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ABSTRACT

Appropriate technology is an approach to meeting human needs which stresses local solutions using small-scale decentralized technologies that have minimal environmental impact. Presented in this manual are 10 lessons for upper elementary students that consider such topics as recycling, solar energy, transportation, and nutrition. Each lesson includes teacher background information, class activities, homework, discussion topics, and a brief quiz. Accompanying these materials are illustrated student handouts that may be duplicated. Also provided are suggested student readings, and a list of other sources of teaching materials. (WB)

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CONNECTIONS

a curriculum in appropriate technology for 5th & 6th grades

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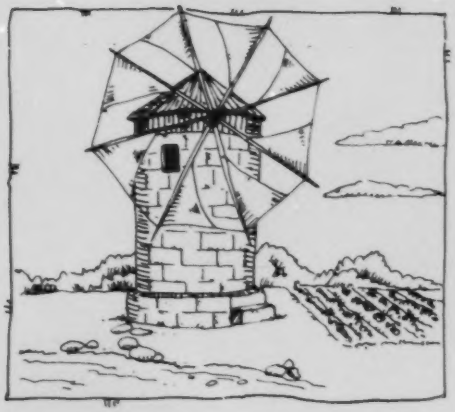

Connections:

a curriculum in appropriate technology for the fifth and sixth grades

WRITER/EDITOR: **JOAN MELCHER**
RESEARCHERS: **SUE ALWARD, CAROLYN SMITHSON**
GRAPHIC DESIGNER: **MIKE DIVEN**
ILLUSTRATOR: **SOPHIE DIVEN**
TYPESETTER: **CINDI RUCKER**

Important contributions to this publication also were made by other NCAT staff:
Brian Mertz, Publications Editor
Kris Ellingsen, Graphic Designer
Steve Marlens, Technical Writer

Three teachers at Butte's John F. Kennedy grade school were instrumental in the development of the curriculum.
Joyce Dresser
Allen Kohler
John Ries

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PREFACE

Welcome to NCAT'S appropriate technology curriculum, a new approach to teaching how our energy, food, transportation and economic systems interact.

The curriculum is the product of many people's efforts and talents. It began in 1978 in a fifth grade classroom in Butte, Montana. Two teachers, Carolyn Smithson and Sue Alward, developed the core of the curriculum while working with the class and local teachers, and based on research conducted at the National Center for Appropriate Technology.

Following minor changes and additions, their material was organized into today's curriculum. The curriculum then was pilot tested in several states across the country. A few more changes were made and illustrations were added. This is the result.

Teachers have asked how the curriculum is meant to be used. Our answer is, however it works best for you. We have organized it into 10 lesson plans, each with suggested discussion tops, classroom activities, take-home assignments, vocabulary listings, and a brief quiz at the end.

A common method of approaching the material is to set aside an hour or two a week for 10 weeks, taking a lesson a week. But there are many other possible paths.

We have tried to make the curriculum as interdisciplinary as possible. You'll find math activities, art projects and recreation ideas. However, the bulk of activities and exercises relate to social studies and earth science. The curriculum can be adapted to just about any scholastic discipline. Discussion topics and class projects may be pursued during the hours set aside for various subject areas.

The activities found in the lesson plans can be done consecutively in an intensive 9 or 10 week period, or randomly over the course of a semester or a year. Each lesson plan contains many more activities and discussion ideas than can be completed in an hour, or even a day. We have tried to present an abundance of ideas and suggestions, knowing different climates and ways of living present different problems, different challenges in teaching. It is our hope each teacher can find in each lesson several activities and discussion ideas that are appropriate to his/her class.

The curriculum is organized into three main areas: lesson plans, student handouts and teacher background. We have included an introduction to appropriate technology and the tools and processes associated with it. This and other readings (indicated in the table of contents) are meant for the teacher. These articles and essays are meant to provide a general knowledge that will enable the teacher to lead class discussions as well as to respond to the many questions that arise in fifth and sixth grade classrooms.

The curriculum also contains instructions and practical tips for the teacher, such as the graphic illustrations for making recycled paper and solar models. These pages were produced with the teacher in mind, but also may be duplicated for students.

Other handout material was aimed directly at the student. Many of these handouts illustrate concepts, such as energy use through history, the possibilities for recycling industrial and agricultural waste, and four approaches to getting food from the grower to the consumer.

We have duplicated these handouts in the back of the book on perforated pages. The teacher can tear them from the book and copy them for distribution to the class.

We also have included a glossary of terms used, a guide for further reference for teachers, and a children's bibliography in renewable energy.

We hope the curriculum works for you. We wish you many happy, productive hours in teaching the concepts and processes here. We hope they will direct you and your class to a better understanding of technologies which are appropriate for the future.

WHAT IS AN APPROPRIATE TECHNOLOGY?

In its broadest sense an appropriate technology is a local, small-scale approach to a universal problem. All people have similar needs – food, shelter, employment, spiritual fulfillment. The way we have come to provide for these needs in this country and in most of the industrial world is through large, complex, expensive processes.

For example, coal is mined in Montana and hauled by rail to Minnesota, where it is used to fire a generating plant. The plant produces electricity that is fed through complicated networks into individual households. Acres of wheat are grown by one farming family in Iowa, harvested, transported, processed and transported again, finally to appear as bread on a table of a family in Florida.

Appropriate technologies attempt to bring these processes a little closer to home. A man who installs a solar collector to heat water for his home is decreasing his dependence on electricity produced miles away in a plant whose workings he neither understands nor controls to any degree. And he is helping to conserve dwindling fuel reserves while putting a free, clean energy source to work for him. A family growing a garden saves money on produce in the summer and fall, as well as in the winter if they preserve and freeze their produce. And they are ensuring a nutritionally sound food supply for themselves while enjoying a close association with the land.

Since the concepts behind appropriate technology are largely means of addressing problems, appropriate technologies are as numerous and diverse as the people who use them. A city dweller in Kansas buys wheat from a farmer and grinds it for bread. A family living in the Rocky Mountains taps a nearby geothermal hot spring and pumps the water to heat its home. Residents of a poor neighborhood in New York organize to save the tenement building where they live, a plan that involves renovation, weatherization and rooftop solar collectors. These examples have one thing in common: All try to reduce the number of middlemen between people and the technologies they use.

Webster defines technology as "the totality of means employed by a people to provide itself with the objects of material culture, a technical method used to achieve a practical purpose, and the application of scientific knowledge to practical purposes in a particular field."

Use of the word "appropriate" takes the definition one step further.

Appropriate technologies address not only the method of a process, but also its means and application – how it relates to the environment where it is used, and to the people who use it. Appropriate technology stresses use of local resources in a particular area; it stresses small scale approaches, and application by individuals and communities who take resources and technologies into their own hands; it stresses use of tools (solar collectors, wind generators, methane digesters, waterless toilets, compost piles) that fully utilize renewable resources.

Both words in the term are important. Appropriate – meaning suitable, compatible – defines the technologies. Technology need not be a complex and expensive tool used only by select experts. Technologies that are "appropriate" are compatible with the natural environment – the demands and limitations associated with it – and the health and well-being of the people they serve. The technology is appropriate because the people themselves have found it appropriate to their needs.

Appropriate technology (a.t.) embraces a wide spectrum of practical processes. Following are brief descriptions of the most commonly known processes associated with a.t.

Solar Energy

The sun is the earth's life-giver. Besides keeping our planet at a relatively constant temperature, the sun is the power behind all natural growth and nearly all natural processes. It controls the wind, the water and the air. If harnessed effectively, the sun's potential as an energy source is enormous.

Growing interest in using the sun's energy for specific purposes has resulted in the development of a wide range of solar systems in use today. The systems range in application and design according to the vision of the users, the climate where they are used, and available materials. But basic principles govern their implementation.

The most common use of solar energy is found in any home with a south-facing window or a clothes line. More specific use of the sun is found in collector systems that heat water for domestic use and in the heating of individual homes and buildings. Passive or active solar systems for home heating account for a large number of the total solar systems in the U.S. today.

All solar systems use some form of collector to trap the sun's heat. The form of **solar collector** most often associated with the term is constructed like a shallow box or tray and covered with one or more layers of **glazing** (a transparent sheet usually made of acrylic, fiber-reinforced plastic or glass). After solar radiation passes through the glazing, it strikes an opaque **absorber plate** in the back of the box and is converted to heat, which is trapped inside. The fact that glazing is transparent to light but traps heat is known as the **greenhouse effect**.

An **active solar system** uses fans or pumps to move solar-heated air or water from collectors directly into a structure, or into storage for later use. It is called an active system because it requires external mechanical power to move the collected heat.

A **passive solar system** uses no mechanical devices to move the collected heat. Most passive sytems are designed to store the heat directly where the sunlight strikes the building's walls or floors. Some passive systems utilize separate collectors, and circulate the air by natural convection. Passive systems are architecturally designed to shield the

structure from unwanted summer sun, while utilizing materials inside that absorb and retain the sun's warmth during the colder winter months (when the sun is lower in the sky). Virtually all solar designs include use of **thermal mass storage** in the form of rock beds, water tanks, concrete walls, or other materials that store the heat for use during cloudy weather or after the sun goes down.

Efficient passive and active systems can be found in every region in the country. With home heating costs rising, solar systems, along with other renewable resource systems, are beginning to compete with conventional heating systems in cost-effectiveness. The rising costs of imported oil, along with accompanying inflation, are making use of renewable energy systems a patriotic exercise.

Solar Age magazine has reported the results of a survey taken by the Solar Energy Research Institute. It showed that .5 percent (about a quarter of a million) of the nation's adult population owned a solar heating system in 1979. About 6 percent (around 9 million) of that age group reported an interest in investing in a solar system.

One of the users of the systems in operation in 1979 was the President of the United States. A large solar hot water system was installed on the west wing of the White House in 1979. The 34-collector system, complete with three 200-gallon storage tanks, has provided about 75 percent of the White House's hot water needs.

Wind Energy

About two percent of the solar radiation that falls on the earth is converted to wind energy. When the sun shines on one part of the earth, the other hemisphere is left in the shadow. Factors such as cloud cover, topography and seasonal variations result in uneven heating and cooling over the surface of the earth. The air moves in mild breezes gusty winds, tornadoes and hurricanes.

The kinetic energy of moving air masses can be harnessed by windmills to provide mechanical energy to produce electricity. The pressure of wind passing through the blades of a windmill can turn a shaft to perform various kinds of work. A windmill can pump water or grind grain, examples of mechanical work. If a generator is coupled to the rotating shaft of a windmill, the mechnical work output of the shaft is converted to electrical energy.

The most widespread use of the wind is found in the classic American prairie windmill. From about 1880 to 1930, an estimated six million windmills turned in the West and Midwest. They were used to pump water and saw wood, as well as to generate electricity for individual homes. In the 1930's rural electric cooperatives brought cheap power to farmers and rural communities, leaving the workhorse of the western plains to stand as a pleasant but somewhat forlorn reminder of simpler times.

An entire generation by-passed the windmills that still dot the plains, but increasing interest in renewable energy led two men in South Dakota to rediscover the commonly used and time-tested Jacobs Windcharger.

Paul Biorn began collecting abandoned Jacobs in South Dakota and renovating them for use in the 1970's. Demand for the Jacobs grew across the country; as the demand grew, so grew Biorn's business, Dakota Wind and Sun in Aberdeen. Orville Lynner joined Biorn and the two developed two generators patterned after the Jacobs, but able to produce 4 kilowatts of power, 1.2 more kilowattts than the Jacobs produced. Dakota Wind and Sun presently builds and sells about 100 generators a year for a ready national market.

On a broader scale, NASA's Lewis Research Center in Cleveland, Ohio, develops and builds wind generators capable of producing megawatts of electricity. Funded by the Department of Energy, the center operates the largest wind turbine in the world in Boone, N.C. It produces two megawatts of power and feeds directly into the general energy grid.

Windmills may become an especially effective source of energy when linked to hydroelectric dams. Various geological and seasonal factors may point to a practical coupling of the two energy producers. For example, an area may have a high run-off period that coincides with a low wind period; or the winds may blow most consistently during the warm, dry months. Working in tandem, wind and water may complement each other, allowing constant energy production.

Hydropower

Much like the movement of air through the blades of a windmill, water falling over a water wheel or through a turbine can be harnessed as an energy source. Energy of the falling water turns the water wheel, which turns a shaft to grind wheat, run a textile mill, or do other forms of mechanical work. When water flows through the blades of a turbine, the water's energy can power a generator (as in the many large power generation dams throughout the country).

Small-scale hydroelectric power systems also have great potential as energy producers. Of the nearly 50,000 existing dams over 25 feet high in this country (built mostly for recreational, agricultural and flood-control purposes), only 800 are licensed to produce power. A 1978 Army Corps of Engineers report estimated that 54 million kilowatts – more power than we now get from nuclear plants – could be harnessed simply by installing turbines at dams already in existence.

Before large, centralized energy systems were widely used, small hydro systems operated throughout the U.S., notably in New England, where water was used to power mills and factories as well as for individual homes. Cheap fossil fuels played a large role in the abandonment or disassembling of many hydro systems, but water power is seeing a resurgence today.

In Lawrence, Mass., a dam built in 1845 to divert water to 22 industrial sites – most of them cotton and woolen mills – will live again with the installation of a 14.2 megawatt power plant. The 92-foot dam on the Merrimack River was first used to divert water into two canals that fed the water to mills, which used the mechanical work of the water wheel. In 1911 the mills attached generators to their water wheels, converting the energy to electricity for more ready use. By the 1950's most of the woolen mills near Lawrence had closed and the people in the area were using low-cost oil and coal for home heating. By 1981, when the power plant is expected to begin operation, the economics of energy will again favor water power and an estimated 17,000 homes (15 to 20 percent of the total energy demand) in Lawrence will use electricity from the dam.

In Wilmington, Del., a direct-current hydro plant built at the turn of the century has been restored and now provides about 70 percent of the energy for a 180-acre historical complex, including the Hagley Museum, its headquarters, advanced research offices, a library and several other structures. In the first 30 months of operation the plant produced 3.6 million kilowatt-hours of power, the equivalent of the energy obtained from 7,150 barrels of oil.

Geothermal Energy

Geothermal energy – in the form of

steam or hot water emanating from the earth – can be harnessed for heating of buildings and a myriad of other purposes. In many geothermally active areas, hot water or steam rises naturally from the interior of the earth to form hot pools and geysers. In other places the water or natural steam remains in pockets or reservoirs in the earth's crust. It can be brought to the surface by drilling wells.

The steam can be used to drive a turbine. Hot water from geothermal sources – once it is filtered free of objectionable gases or dissolved solid materials – can be pumped to homes or buildings for heating.

Most geothermal activity in the U.S. is found in Western and Gulf Coast states. Recreational facilities often are built near hot springs and utilize the water in swimming pools and to heat buildings. Fairmont Hot Springs, a resort in the Rocky Mountains in Montana, is heated entirely by geothermal means. The hot water is used three times in the large complex before it is pumped to indoor and outdoor swimming pools.

In Boise, Idaho, geothermal sources have been used to heat homes since before the turn of the century, and today plans are being implemented to tap geothermal wells to provide space heat for the state's capitol complex as well as other government and commercial buildings.

Besides the heating of buildings, geothermal energy has been used extensively for agricultural purposes, to heat greenhouses, for growing food hydroponically, and even as a water source for cattle. Dairy farmers have linked increased milk production to the use of geothermal springs as a drinking source for their cattle, reinforcing a belief held for years by many people that natural hot springs are not only enjoyable, but also conducive to good health.

The largest geothermal energy producer in this country is the Geysers, about 75 miles north of San Francisco, Calif. Operated by a consortium of power companies, the Geysers taps steam from some 75 wells to fuel 11 turbines, producing 500 megawatts of electricity and contributing significantly to the area's energy grid.

Bioconversion

Bioconversion is the process of converting organic materials, or biomass, into usable fuels such as methane or alcohol, through either heat conversion or biological interaction. **Biomass** includes all forms of plant matter and its derivatives, such as residuals from crops and forest lands, animal waste, sewage, and the organic components of municipal solid waste.

The concept behind biomass energy is that plants store solar energy through the photosynthetic process in the form of stable organic matter, which is released as gas when the plants decompose or are burned.

The most commonly known bioconversion in use today is the burning of wood for heat, a direct thermal (heat) conversion. The heat released through thermal conversion can be used directly or to generate steam for power plants. Controlled combustion, often called **pyrolysis** or **gasification**, is used to convert biomass to a mixture of combustible gases, oils and solids.

Chemical conversion is found in the production of methane and alcohol. **Methane**, the primary component of natural gas, can be produced from human and animal waste. Organic waste is shredded, diluted with water and pumped into an airtight tank, which is kept at about body temperature. Over a period of time, the natural bacterial process converts the waste to **biogas**, which is about half methane, half carbone dioxide.

One notable example of methane is found in the City of Los Angeles' sewage plant. Since the early 1950's, sewage sludge has been converted to methane gas, which now powers the plant's 10 diesel engines.

A dairy farm near Monroe, Wash., converts another undesirable by-product – manure – into usable fuel. The farm's animal waste produces enough methane to power a boiler that provides steam for several processes, including the pasteurizing of milk and the making of cottage cheese and cheese. The boiler also contributes significantly to the heating of the processing building.

Alcohol and **gasohol** are other examples of chemical conversion. Grain (usually corn, wheat or milo) is fermented in airtight containers and distilled to produce alcohol. The alcohol can be used directly in modified engines, or mixed at a ratio of about 80 to 90 percent gasoline to 10 to 20 percent alcohol to make gasohol.

At this time, gasohol is produced and sold in several states in the country, notably where grains are readily available for conversion. If produced and used on a broad scale, alcohol fuels could contribute significantly to the available fuel supply. More than that, they would make use of surplus crops, which are by nature renewable resources.

There are many by-products from alcohol and methane conversions, such as carbon dioxide (used to make dry ice and the fizz in soft drinks) and distillers dried grain (DDG), the dry product left after removal of the alcohol. DDG is an excellent protein source for cattle, and other uses are being studied.

Recycling

To most people recycling means taking cans, bottles and newspapers to a recycling center. But the recycling center is only one corner of a much larger picture. Recycling reaches far beyond the reprocessing of a few basic materials. A total view shows recycling to be a philosophy dedicated simply to the finding of a new life for any material, article, product or structure that has fulfilled its original function.

Virtually anything can be recycled. Tires can be shredded to burn with coal. Styrofoam packaging can be reused for pillows and soft-form furniture. The hardwood floor from an old gymnasium can be resanded and used in a new house. Livestock manure can be used in compost piles and methane digesters. The possibilities are endless: oil drums painted black and filled with water for thermal storage in a passive solar greenhouse; newspapers shredded for garden mulch or wrapped to burn in a wood stove; old clothing for quilts or fabric art.

The next life of a car hood might be as a sled. An old warehouse might be born again as a combination art gallery and studio space. Old railroad ties may live again in a landscaped garden. A wine vat may become a hot tub.

The inventiveness of some recyclers clearly demonstrates the limitless possibilities of recycling. A Minnesota "tire king" daily collects truckloads of tires and stores them – sometimes in 40-foot stacks – until they can be shredded and mixed with coal, increasing its burning efficiency. In Butte, Mont., a solar architect converts a 70-year-old cement ore bin to a home: Windows taken from razed buildings provide a spacious view where a loading dock stood before; a solar greenhouse built on the south side of the massive structure provides pleasant living and growing areas as well as contributing to the heating of the recycled building.

Along more conventional lines, the Portland (Ore.) Recycling Team recycles some 850 tons of glass, aluminum and paper each year. In its nine years of operation, the project has established six permanent drop-off sites in the Portland area. The team collects high-grade waste paper from various government agencies and commercial enterprises, paying a

percentage of what the paper would bring at the recycling center. A ready market for the waste paper is found in the many paper factories in the area.

The Community Environmental Center in Santa Barbara, Calif., claims the distinction of recycling more newspaper per capita than any other recycling center in the country. An estimated 70 to 80 percent of the total newsprint output in the south coast area of California is recycled through the center. On-site collection at three beer distributors in the area assures a constant supply of bottles for recycling. Largely self-sufficient financially, the center employs 18 people and pays out an estimated $100,000 annually for recyclable materials.

Appropriate Technology in the Community

An important aspect of appropriate technology is its community orientation. An old maxim – there's strength in numbers – clearly applies to most appropriate technologies. The principles of appropriate technology stress use of local resources in processes which are easily understood and applied, and which require a certain degree of skill and labor. These factors often point to a project too large for one person or one family. This is where the community approach to appropriate technology finds fertile ground: recycling centers, community gardens and canning operations, farmers' gardens, food cooperatives, solar greenhouses – any variety of community or group action.

The community approach can be taken a step further through integration of appropriate technologies in the total community view. In a small town in Massachusetts, members of the Wintergreen Cooperative Solar Greenhouse are building a large commercial greenhouse to grow produce for their food cooperative. The greenhouse will be attached to the building used by the food cooperative. Excess heat on sunny days will be channeled from the greenhouse into the co-op building; conversely, heat from the main building will be used in the greenhouse on cold or cloudy days.

A group organized on New York City's lower East Side began with rehabilitating a burned-out apartment building and have moved on to embrace several appropriate technologies. Using "sweat equity," the group obtained a rehabilitation loan and reconstructed and weatherized the building. All work was done by future occupants whose loan payments once the building was restored were half what their rent had been.

The group went on to build solar collectors on the south wall of a neighborhood gymnasium. Other projects taken on by the group include a community recycling center, community gardens and a solar greenhouse.

Perhaps the most fertile ground for an integrated community approach to appropriate technology is found on the American farm. So many of the basic elements utilized in appropriate technologies are found on the farm: sun, wind, land for growing, biomass, surplus crops, and the essential physical labor and incentive to put everything together. Despite an abundance of the basics, the small farmer today faces the same, if not worse, energy problems prevalent everywhere.

To help farmers deal with spiraling energy costs, the Center for Rural Affairs in Nebraska organized the Small Farm Energy Project, a demonstration project among 25 families designed to implement energy conservation and renewable energy techniques. Among the renewable resources available to farmers that were demonstrated in the project are: wind energy to pump water and for electricity; solar energy for heating water, drying grain and space heating; methane production from manure; production of alcohol and other biofuels from surplus crops or other organic waste; insulation of buildings; and organic gardening, composting and crop rotation.

Like all appropriate technologies, these processes are designed to solve basic problems in the most direct, environmentally compatible way.

Appropriate technologies belong to individuals, groups and communities. They are as ordinary or diverse, traditional or avant-garde, basic or complex as the people who use them. But together they can take us far down the road to energy independence while bringing us closer to our natural environment and our own humanity.

LESSON ONE: INTRODUCTION TO APPROPRIATE TECHNOLOGY

Objectives:

Students should be able to identify various appropriate technologies and to list several of the characteristics that define appropriate technology.

Vocabulary:

appropriate technology
ecology
small scale
conservation
renewable resources

Discussion of Concept:

1. **Define Appropriate Technology**: Give the students a working definition of appropriate technology. Use the definition on the next page or devise your own.

2. **The Poster:** Explain the construction and ecosystem of a greenhouse. Using the resource material, discuss how the various forms of life contribute to cyclical processes in the greenhouse. Compare the definition given for appropriate technology to the function
3. of a solar greenhouse.

   Characteristics: Introduce the students to the characteristics of appropriate technology given in the resource material. Have the students identify the characteristics as they appear in the greenhouse environment. Then have them point out other processes or systems that also exhibit the characteristics of appropriate technology (windmills, community gardens, hydropower, geothermal use). You might want to write the characteristics on the board at the beginning of class so that each becomes more pronounced as you go through the processes.

Materials Needed:

Poster: construction paper, poster board, writing tools for balance chart

Class Activity:

1. **The Balance Chart**: Construct a poster board or hanging circle of construction paper as a balance chart (refer to resource material) or draw a simple chart on the board. Discuss the different technologies and how the four elements balance.

2. **Closer to Home**: Bring a photo of one or more appropriate technologies in your area. Have the students list and define the characteristics of appropriate technology that apply.

3. **How Many Can You Name**: Erase the list of characteristics from the board. Have the students write down as many as they can remember. Give an appropriate prize for the one who names the most.

Home Activity:

1. **A Potential Appropriate Technology**: Have the students write a story describing the workings of a potential appropriate technology for their community or family.

2. **For the Next Lesson**: Have each student bring one news clipping or magazine article that reports on a shortage or conservation method for discussion in the next lesson.

Preparation for Next Lesson:

Prepare for the Heat Leak Detective game; arrange for a guest speaker or for a field trip if you plan to do either activity.

Appropriate Technology

What is appropriate technology? For simplicity and directness, the definition by L.C. Birch, an Australian ecologist, seems itself most appropriate. AT is "small scale technology with a human face." Appropriate technology tends to be:

1. Small in scale – operations of a size which are manageable directly by people;
2. Decentralized – resources supplied and technically controlled locally;
3. Simple in basic operational design, though not necessarily in materials used or research applied;
4. Ecologically integrated – efficient of renewable resources, and non-contaminating;
5. Socially manageable – because of above, AT enhances human self-esteem and self-reliance.

The required capital investment, renewable energy resources, and operational skills are usually within reach of individuals and small groups. Appropriate technology can efficiently satisfy basic human needs such as energy, food, water, and waste disposal. But, more importantly, it can do so by making a person the producer as well as the consumer.

For the most part, these needs are presently satisfied by large, centralized and complex technological systems which are dependent upon extraordinary capital investment, non-renewable energy sources, and sophisticated, mostly automated control operations. Of necessity they must be managed by government or by large corporations, both public and private. These large systems are more and more subject to disruptions from supply problems, labor disputes, lack of capital, and technological breakdown. This growing unreliability is a signal for rethinking the best way to supply basic human needs.

However, a.t. is not 18th and 19th century technology restored! It may require specific advanced technologies, i.e. photovoltaics, electronic controls: fabricated materials, etc., and it may require advanced manual skills and understanding of technical information. AT is a technology of small-scale reminiscent of simpler times, but employing appropriate 20th century technical advances.

Interest in a.t. fundamentally reflects a group of responses to life in present-day America – a response of uneasiness with ever-expanding growth; a response of nostaligia for a simpler time; and a response from alternate lifestyles which depart from the pace and style of current complexities.

More specifically, there is a growing feeling among many Americans that the continuous, exponential human and economic growth, experienced and enjoyed by many since World War II, is unrealistic for the future. Because of environmental, social and resource (particularly energy) constraints, continous growth is, in all liklihood, undesirable, and probably impossible. Images of a.t. also evoke nostalgic reminders of a simpler time, thus appealing to the current mood for preserving the old ways. Interest in a.t. suggests possiblilities for alternative lifestyles, another appealing interest befitting the current mood of uneasiness with our prevailing and pervading complex 20th century society. Appropriate technology speaks to all of these. Employing a.t. does alter lifestyle and does suggest different technical foundations – some old, some new – for satisfying basic human needs – needs such as energy, food, water and waste disposal.

a.t. advocates small operations and decentralization such as cottage industries, households moving toward self-sufficiency, recycling, a labor-intensive approach rather than automation and other ideas that lessen waste and unnecessary complexity. Also, a.t. suggests that the most efficient way to deal with needs is to accomplish the goal in the simplest way possible. So, as an added bonus, a.t. offers the beauty of simplicity. Life **can** be less frustrating and more paced. Appropriate technology does not challenge the good life, only the hectic life.

In some respects, using appropriate technology is analogous to the functioning of an ecological system. The energy sources for a.t. (sun, wind, water, etc.) are renewable and for the most part, universally distributed. For this reason the energy sources are locally available requiring only a technology of capture, much as the green plant captures the energy of the sun. Because a.t. can be supplied by renewable energy sources, it is ecologically sound and generally environmentally acceptable. Food, energy, water, and human waste disposal, all biological necessities, may also be handled locally using a.t., thus replicating the ecological food and water system. Recycling and reusing organic and manufactured materials has its ecological counterpart in the cycling of mineral nutrients within the ecosystem. And, finally, basic to all ecological systems is the prudent use of natural resources, which when translated into human terms means resource conservation.

*By Louis J. Laux, Ph.D.
National Science Foundation Resident
Ohio Institute for Appropriate Technology

Class Discussion

A Working Definition: Technologies are the processes we use in nearly every aspect of our lives. Tools, mechanical devices and methods used in these processes help us do many things, such as growing and preparing food and harnessing energy for use in factories and for our homes and schools. Appropriate means to use these processes in a way that is harmonious with other people within our community and in the natural world where we live.

Characteristics of Appropriate Technology

1. Appropriate Technologies make use of locally available materials.
2. Appropriate Technologies make use of renewable resources.
3. Appropriate Technologies can be understood, built, operated and maintained by the people who use them.
4. Appropriate Technologies usually are smaller and less expensive than more complex systems.
5. Appropriate Technologies are simple, flexible; they can be adjusted to fit different situations and to solve different problems.
6. Appropriate Technologies stress conservation of energy.
7. Appropriate Technologies require human skills and labor.
8. Appropriate Technologies stress the importance of ecology.
9. Appropriate Technologies stress community efforts in the solving of problems.

The Solar Greenhouse

Until recently most greenhouses were built as glass houses that effectively captured solar radiation for growing plants, but were ineffective in storing the sun's heat. Most of these greenhouses required some form of heating at night.

The "solar greenhouse" is a relatively new concept, designed to capture the sun's heat, hold it, and radiate it back into the greenhouse through the night, eliminating the need for an expensive backup heating system. The main principles of solar greenhouse design call for well-insulated walls and ceilings, and glass or glazing on the south side (angled to make best use of the sun's rays according to the climate and latitude where it is built.) The roof is angled to reflect light onto the growing space, and a heat storage system is built-in.

Methods of storing heat involve use of thermal mass, such as oil drums filed with water and painted black; concrete slabs; or beds of earth or rock.

A solar greenhouse can be built as a free-standing structure or attached to the south side of an existing building. Attached greenhouses not only provide a convenient place for growing plants and vegetables, but also are designed to circulate warm air into the main structure, contributing to the heating of the building.

The Plants

Plants can be grown in a greenhouse all year long, providing fresh, nutritious food for individuals and communities, and cutting grocery costs. Growing and harvesting food close to home also lessens our dependency on a complex farm – market – consumer system that is heavily dependent on high-energy transportation and processing procedures.

The Rabbits

Rabbits also can be raised in the greenhouse. One of their main contributions to the ecosystem occurs when they exhale carbon dioxide, a vital requirement for the healthy growth of plants. Growing plants give off oxygen, but need to take in carbon dioxide.

Unless there is a supply of fresh air, carbon dioxide is rapidly depleted. The solar greenhouse is not easily vented without a noticeable heat loss, so it is important to insure a constant source of carbon dioxide. Experiments have shown that rabbits in a greenhouse effectively raise the carbon dioxide content in the air.

Plant wastes in the greenhouse can be fed to the rabbits – only one of many closed cycles in a greenhouse – eliminating waste and allowing for a natural cycle of growth, use and decay. The rabbits can be raised for fresh meat. And their droppings can be used as fertilizer for the plants, either after composting with other wastes, or directly applied to the soil after a period of time.

The Fish

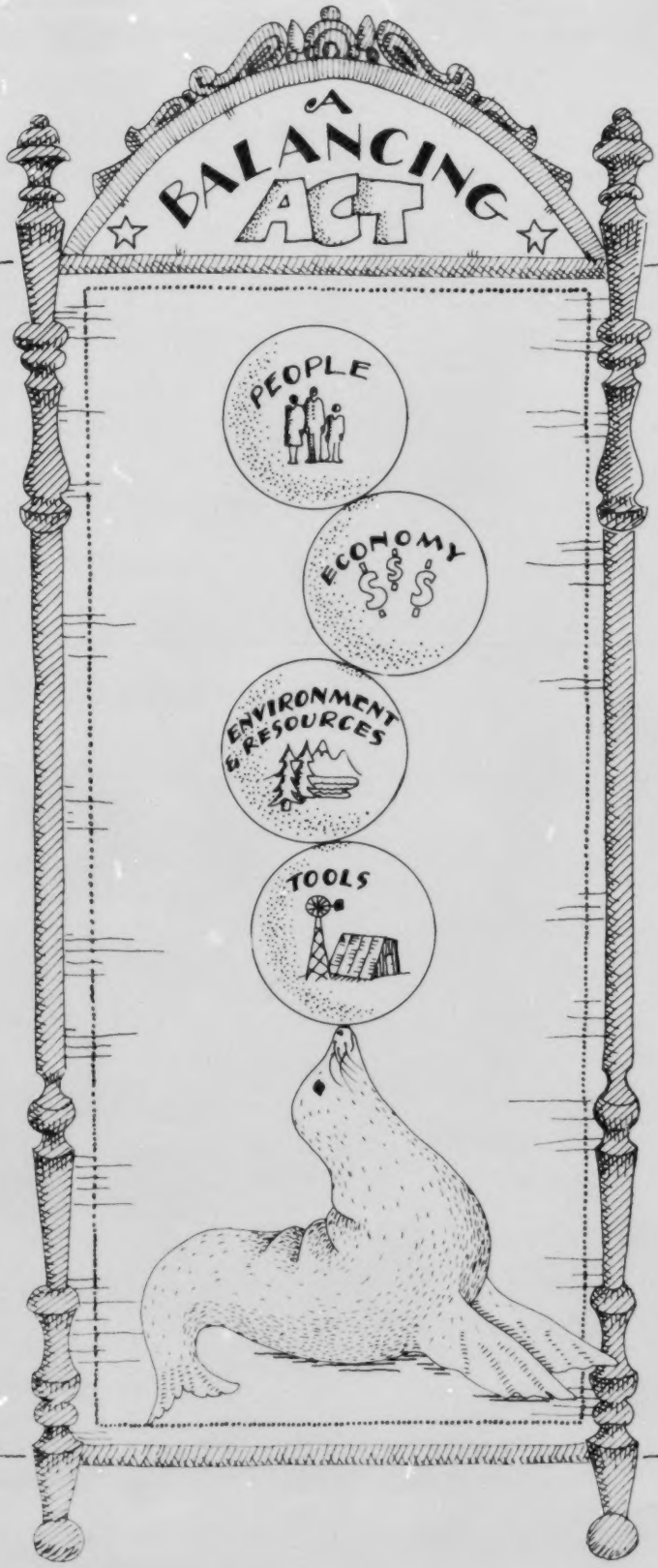
The greenhouse is a miniature ecosystem. Besides providing an ideal climate for the growth of vegetables and plants, a solar greenhouse also accomodates other crops. Some greenhouses have been designed with water barrels or tanks that serve as thermal mass for storing the sun's heat and also provide an environment for raising fish. The fish most often raised in greenhouses today is the tilapia.

Species of carp also can withstand the crowded conditions in the tanks, the rather murky water, and variations in water temperature. Carp are commonly raised in fish farms in China and parts of Europe. And various groups in the United States also are beginning to introduce fish farming into the greenhouse environment.

The Insects

Insects are a frequent problem in any garden. Chemically-based pesticides are used by many people to control insects. However, biological control provides an alternative to costly chemical pesticides that may leave unhealthy residues on plants.

Biological control involves the use of bugs that eat other bugs, more specifically the use of predator insects to control plant parasites such as aphids. A ladybug is a good example of a predator insect that feeds on bugs that feed on plants. Other examples include the praying mantis, the green lacewing and the trichogramma wasp.

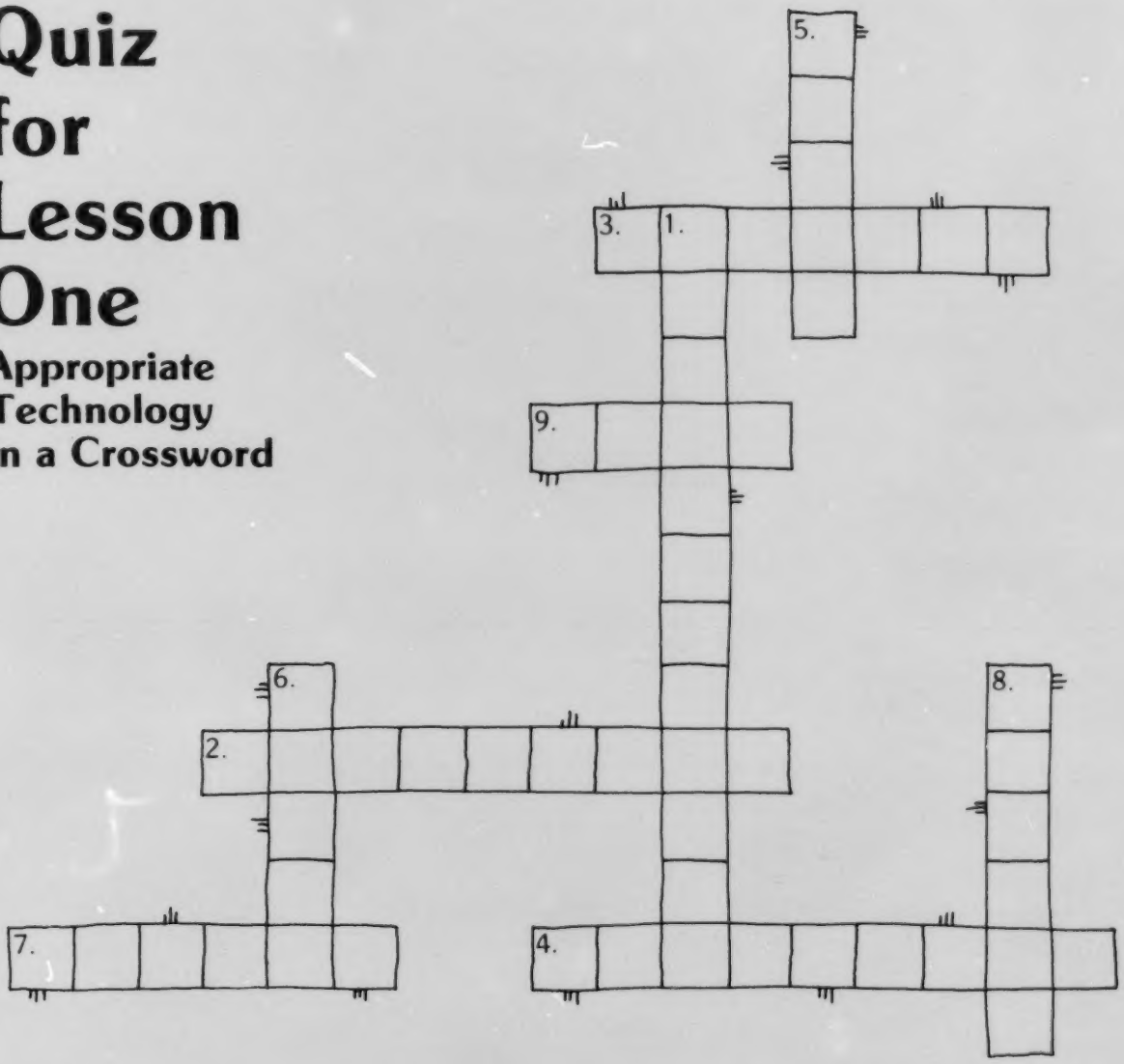


One of the important aspects of appropriate technology is that it stresses balance and harmony in the intricate network of the individual, the community and the natural environment. To be appropriate the people, economy, tools and resources involved in a technology must be in balance with one another. The tools used should compliment the people, their resources and their environment. If not, the balance is lost. If the economic aspect is stressed at the expense of the environment, the balance will be off. Refer to the processes of appropriate technology presented in the poster and introductory material. Discuss the balance of each of the processes.

Are there some technologies that balance in one environment and not in another? Would hydrogeneration make sense in a desert region? Would a complex and expensive nuclear power plant be appropriate in sunny Mexico? Have students identify energy or food sources in their area. Do the four factors balance out in food and energy production? Are people finding work in their area, or is unemployment a problem? Are the tools (farming equipment, power plants, factories, any means of production) used in their area appropriate to their resources and environment? Can they think of tools that would be more appropriate to their climate, resources and way of life? What technologies might employ more people? Is the food and energy their parents pay for economically produced? Can they afford what they need? Could people in the area save money by using another food or energy production method? Have the students take one technology common in their area (farming, coal generation, fishing, manufacturing, tourism) and discuss its balance. Have the class think of a technology appropriate to their area that is not being used at this time.

Quiz for Lesson One

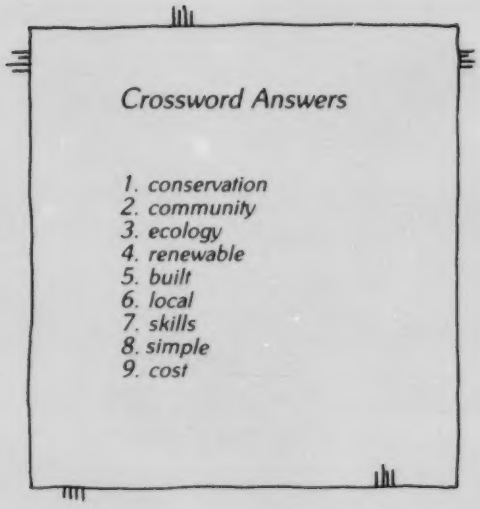
Appropriate Technology in a Crossword



A good example of appropriate technology at work would be: a) a factory b) a community garden c) a town parade. List all the characteristics of appropriate technology that apply to the example you choose.

Fill in the crossword puzzle with characteristics of appropriate technologies.

1. Appropriate technologies stress _____ of energy. (down)
2. Appropriate technologies are part of the_____(across).
3. Appropriate technologies stress the importance of our natural world and _____. (across)
4. Appropriate technologies use _____ resources. (across)
5. Appropriate technologies can be _____ by the people who use them. (down)
6. Appropriate technologies use _____ materials. (down)
7. Appropriate technologies require human _____ . (down)
8. Appropriate technologies usually are _____ systems (down)
9. that _____ less than more complex systems. (across)


Crossword Answers
1. conservation
2. community
3. ecology
4. renewable
5. built
6. local
7. skills
8. simple
9. cost

LESSON TWO: CONSERVATION

Objectives:

Students should be able to distinguish between fossil fuels and renewable resources and be able to identify conservation measures used in their area.

Vocabulary:

"Spaceship Earth"
fossil fuels
mass transit
weatherization
car pool
historical restoration

Discussion of Concept:

1. **Conservation and Finite Resources**: Using resource material, briefly discuss the historical use of energy, pointing out that our current dependence on fossil fuels (finite resources) is only a short span in the time continuum of energy source use. Discuss conservation as it relates to the concept of "Spaceship Earth." What is limited on the spaceship? What happens when we run out of those materials?

2. **Shortages in Your Area**: Discuss the articles the students brought to class. Could conservation have prevented the shortage or limited its impact? Is there a solution to the problem? If so, what are the costs?

3. **How Do You Conserve**: Discuss conservation methods used most often in your area: weatherization, water recycling, mass transit, car pooling, energy-saving methods in the kitchen, solar collectors, windmills, waterless toilets. Take the four basic areas of Food, Shelter, Energy and Transportation and see how many conservation methods and techniques the students can name for each.

Materials Needed:

Articles for discussion; plastic food wrap, pencil and scotch tape for Heat Leak Detective game.

Class Activity:

1. **The Heat Leak Game**: Have the students find heat leaks in their school building by playing this game (described in the resource material).

2. **Guest Speaker**: Invite a guest speaker to discuss a conservation technique or example of conservation appropriate to your area. Those in cold climates might invite a person from the local Community Action Program to discuss weatherization; those in dry climates, a person who can discuss water conservation; if restoration attempts are being made in your community, a person from the historical society might make a good guest speaker. Or take a field trip to one good conservation demonstration.

Home Activity:

1. **Water Conservation**: Have the class read "Drip the Water Drop" and complete exercises.

2. **Energy Conservation:** Have the students write a story describing life during a blackout, a fuel shortage or period of water rationing.

Preparation for Next Lesson:

Look for some photos or drawings of off-beat modes of transportation that either are powered by human or renewable energy, for class discussion; bring beans for Hare and Tortoise game.

A Historical Perspective on Energy

Energy is defined as that commodity which gives men the capability to do work. Early man acquired the metabolic energy necessary to survive by gathering and eating plants. Later, he used his energy to hunt small animals. Because meat contains more concentrated protein than plants, the time spent eating was reduced by two-thirds, leaving time to stalk large animals. Such activity, of course, required greater social interaction and greater communication efforts. One result was that, about 400,000 years ago, man discovered how to use fire. Man's new energy source provided him with heat, light, protection, and increased variety in his diet. More importantly, however, he learned to use fire to extract metals from their ores and forge tools.

At the same time that man first began to use copper (10,000 BC), he began to farm. The harnessing of energy for agricultural purposes made possible the development of stationary rather than nomadic communities. Up to this point, man relied upon the sun for energy. Not only did the sun directly warm his body, but it was indirectly responsible for the production of his food and fuel (wood). Although he was able to use fire to extract metal from his ores, his total energy requirement was low. The Egyptians, Greeks, and Romans brought about significant changes in energy by developing waterwheels and mills. It is known that vertical waterwheels were being used even earlier. Although its benefits were understood, water power was not taken advantage of during the early years of the Roman Empire because it was thought that individuals' jobs would be replaced by water power; it was even necessary to ration water to the mills in order to assure that everyone had an adequate supply. While the Romans had aqueducts to regulate their water supply, most civilizations depended upon the seasonally changing natural flow of rivers for their water power.

Very little energy technology development took place between the Fall of the Roman Empire and the end of the seventeenth century. Some energy-harnessing tools were invented and used; for example, by 1066 there were, according to Domesday book, 5,000 waterwheels in England. Windmills, appearing first in Persia during the seventh century, did not appear in Europe until the twelfth century but were a common sight 100 years later. Both waterwheels and windmills relieved man from physical labor and provided goods which aided the growth of towns and commerce. Also, during the ninth and tenth centuries, the horse was utilized more efficiently in Europe: the horse collar, the tandem harness, and the iron horseshoe were introduced. The pulling power of the horse, because of these aids, was three to four times greater than it was during Greek and Roman times. But although few technological developments took place, a significant change in energy did occur; in Europe coal became more and more important as a fuel during the sixteenth and seventeenth centuries because wood, which had been the main source of fuel used by the pyrotechnical trades (soap and glassmaking, the metallurgy), had become more and more scarce. Civilization was switching from renewable (replaceable) energy resources to non-renewable (irreplaceable) resources.

The greater demand for coal meant more coal mines. It also meant deeper mines from which drainage of water became more and more difficult. During the sixteenth and seventeenth centuries waterwheels and windmills had been used to drain mines, but they were not reliable and depended upon a suitable location. A more efficient device was needed. The result was the steam engine. In 1698 Thomas Savery constructed a steam pump, what he called a "fire engine," for mine use. A short time later, Thomas Newcomen developed an atmospheric steam engine, the first engine to convert heat energy into mechanical energy on a large scale. His engine could raise 50 gallons of water per minute from a 156-foot depth. Later improvements were made by James Watt, who increased the engine's efficiency and adapted it to give rotary mechanical motion, necessary in eighteenth century textile mills.

Increased coal production also meant increased iron production. The mid-eighteenth century marked the beginning of a mechanized civilization increasingly dependent on nonrenewable resources (1755 is usually given as the beginning date of the Industrial Revolution). In 1776, Matthew Boulton began his partnership with Watt to build a new steam engine. When James Boswell came to visit Boulton's Soho Foundry in that year, Boulton said to him proudly, "I sell here, sir, what all the world desires to have – power." Power – the product of harnessing energy sources – became a new and important aspect of civilization.

Watt, around 1776, developed his steam engine without much technological knowledge as to how the engine actually worked. During the first half of the nineteenth century James P. Joule, Sadi Carnot, and Rudolf Clasisus formulated the laws that define the relationships among energy, work, and heat. These laws are known as the Laws of Thermodynamics and can be summarized as follows:

1. Energy and matter can be neither created nor destroyed.

2. The energy of the universe is constant, but the energy of the universe increases toward a maximum.

The importance of these laws cannot be overstated. Their formulation meant that energy could be understood theoretically for the first time.

After 1850, the theory of thermodynamics provided the theoretical basis for the improvement of the steam engine as well as the basis for the development of other heat engines. The science of thermodynamics was applied in other ways; for example, Beau de Rochas in 1862 formulated a theoretical cycle of operations that would give an

efficient internal combustion engine. In 1883 Daimler introduced his petrol engine, and by 1885 Priestman had developed a heavy oil engine.

Man's increased control over energy in the early nineteenth century resulted in the switch from individually produced items to mass production of both goods and machinery. The precision of engineering and the speed of machines were improved at this time. While the energy developments were taking place, the population of Europe increased to 200 million people. Energy support of this population was not possible through domestic means alone; animals, grains, and other food stuffs had to be imported. Heretofore, the energy supply had been sufficient to feed all Europeans and their work animals and at times sufficient to supply a surplus for export. Thus, while one sees in this period a vast increase in power and energy knowledge, one also sees in Europe the beginning of a dependence on other parts of the world for basic energy resources.

American Energy Perspectives: 1800-1974

Wood, water and wind were the major inanimate sources of energy in the United States for most of the nineteenth century. Wood, a source of energy (power) and heat, was important to both home and industry and was the principal fuel used by railroads until about 1870. Unfortunately, most wood used during the nineteenth century was not consumed in stoves, but in open fireplaces – an extravagant and inefficient use of an abundant resource.

As wood became more expensive and less readily available, coal began to replace it for home heating and industrial steam generation. By the middle of the nineteenth century, half a ton of coal could replace two tons of wood at half the cost. In 1885, approximately equal amounts of energy were obtained by Americans from wood and coal.

Early coal mines in America were generally small operations. Due to their tremendous need for fuel, the nineteenth century railroad companies purchased large tracts of coal banks. The wholesale price of soft coal increased from $.90/ton to $4.88/ton by 1949.

Eventually, efficient and cheap lubricants and illuminants were needed to replace scarce, expensive animal (especially whale) oils. The Pennsylvania Rock Oil Company found the answer when it struck oil in 1859 near Titusville, Pennsylvania. Early American oil wells were extremely wasteful; because oilmen did not understand geology, uncontrollable gushers often wasted oil at a rate of 3,000 barrels a day. By 1869, 4,215,000 barrels of oil (the equivalent in energy content to approximately one million tons of coal) were being produced annually in the U.S.

Another energy source, natural gas, was known to the earliest colonial settlers, who encountered it in swamps and when drilling water and salt wells. But until the 1870's and 1880's gas was generally considered a nuisance – a waste product. Wood and coal provided necessary heat and kerosene was used for lighting. In 1878, a large gas well was discovered near Murrysville, Pennsylvania, and in 1883 a pipeline running from this well to Pittsburgh was opened. In 1884, serious searches for natural gas resulted in the discovery of large gas reservoirs which were soon tapped in order to supply local industrial plants with cheap fuel.

Even though large reservoirs of natural gas were found during the latter part of the nineteenth century, natural gas could not be used extensively because an adequate way to transport it had not been developed. Efficient, long-distance gas transportation was not perfected until the mid-1930's when seamless, pressurized steel pipes were first manufactured.

Along with the new energy sources came many new energy technologies. For example, in 1879 the electric light was invented; in 1882 the world's first electrical power and generating distribution system was built in New York; in 1882 the first hydroelectric power facility began generating on the Fox River in Appleton, Wisconsin; and in 1896 the plant at Niagara was in operation.

New technologies and discoveries of new energy sources resulted in a redistribution of the traditional sources and uses. The work derived from animals exceeded that obtained from all inanimate sources of energy until well into the second half of the nineteenth century. In 1870, the work output of inanimate energy sources was about equal to that of animals. By 1900, the work output derived from inanimate sources was more than three times greater than that derived from animals. During the early twentieth century, the amount of wood used was still substantial, but wood contributed little to the total energy pool. From 1900 to World War II, wood was primarily used for residential heating and cooking.

From 1885 until World War I, coal was the dominant U.S. source of fuel energy. In 1914, the strip-mining technique was introduced to coal mining and became an important mining method in the Midwest which contributed to the wide use of coal as a fuel. Before World War I, six times as much energy was produced by coal as by petroleum; this was reduced to three times as much by 1925, and in five years (1930), the ratio had dropped to approximately two to one.

Petroleum became an increasingly important energy source in the pre-World War II period, as did natural gas. The U.S. demand for fossil fuels – coal, petroleum, and natural gas – became so great that by 1955 the U.S. was a net importer of fossil fuels; in that year, 2.1 percent of all fossil fuels consumed in the U.S. were imported.

In 1900, hydroelectric power accounted for 57 percent of all electricity generated, but by 1950 accounted for only one-third. On the other hand, total electricity generation increased steadily until the end of World War I when it began to accelerate rapidly. Excluding World War II, the annual per capita growth rate of electricity has been seven to nine percent since the mid-1930's.

During World War II, progress was made in harnessing nuclear energy. A nuclear chain reaction was first demonstrated in 1942; the first atomic bomb was exploded in a test in 1945; and in 1951 electricity was first generated from atomic energy. Nuclear energy now provides about fifteen percent of our electricity. Figure 1 summarized the amounts of fuels used in the U.S. since 1850.

The oil crisis did not create the U.S. energy problem – it merely hastened U.S. awareness of a situation that had already existed for many years and was steadily worsening. The U.S. depends heavily on dwindling fossil fuels; furthermore, it depends most heavily on the least abundant fossil fuels – gas and oil – for about 75 percent of all its energy.

In the twentieth century, as the U.S. energy demand grew, the U.S. energy supply did not keep pace. Coal production peaked in 1947. Crude oil exploration declined until 1971, but picked up considerably in 1974; still, new discoveries are not keeping pace with consumption. Since 1968, natural gas consumption has outpaced the discovery of new supplies, but reserves are dropping and production has begun to decline. At the same time, our energy consumption has increased by about four percent a year – we imported 35 percent of our oil in 1973, between 40 and 45 percent in 1976, and approximately one half of our oil in 1979.

Why Energy Conservation?

Increased conservation awareness, higher prices, and new public policies have resulted in significant reductions of energy consumption; for example, in 1975 conservation measures helped bring energy consumption to 12.4 percent below the amount earlier projected for that year. Other estimates suggest that energy conservation can bring about a one-third reduction in energy consumption without curtailment.

"Conservation" means the wise use of energy; it can be a natural response to price change, a shift from less to more available fuel resources, or simply a well-insulated house with an efficient heating system.

"Curtailment," on the other hand, causes or induces denial; for example, an oil embargo requires curtailment or cutting back petroleum consumption. Curtailment means a cold house in the winter even though it's a well insulated house. Conserving energy resources now means avoiding possible curtailment of those resources in the future. Conservation as a long-term necessity should be implemented for many reasons, including five suggested by one energy expert:

1. Conservation activities save money, and lower cost energy resources can often be used to achieve the same ends as high cost energy resources.

2. Conservation expands the range of energy choices because it permits citizens to select those energy supply technologies that are most acceptable (for example, solar energy) and reject those that are relatively objectionable (for example, coal energy).

3. The U.S. dependence on unreliable and costly supplies of foreign oil can be reduced by conservation measures.

4. Conservation can free scarce energy resources for use in developing countries. The value of an incremental supply of energy n a developing country may be much greater than in a developed country.

5. Conservation measures will help provide energy resources for future generations; furthermore, they will help to prevent future generations from having reduced standards of living.

An Energy Conservation Ethic

Some sort of ethic stands behind every moral principle. Historically, Americans have believed in a "Work Ethic" – work as hard as possible, produce as much as possible, be as comfortable as possible, and be as successful as possible in terms of income and acquisitions. As a result of this productivity, our society has become increasingly prosperous and we have grown with little concern for future generations.

In the past, energy and technology increased worker productivity and provided an outlet for improved disposable income (longer vacations, more expensive cars, added conveniences at home). As a result, American society has become increasingly energy-intensive and wasteful. Now that American energy supplies are dwindling, it is essential that some behavioral changes occur in our society.

In order to slow the exponential energy demand growth rate which may limit energy options available to future generations, citizens must adopt an Energy Conservation Ethic. Such an ethic not only can induce cost-saving responses, but also productively change the American way of living. Teachers have the opportunity to make clear to students that such an ethic is based on a realistic comprehension that so many of the raw materials on which current living standards rely will not be available much longer.

It goes without saying that conservation measures cannot be effected without some action by the consumer; such measures may not only alter the "comfort" citizens derive from consumption, but also their "freedom" to consume. As observed in the **Scientist's Statement on Energy Policy**: One man's conservation may be another man's loss of job. Conservation, the first time around, can trim off the fat, but the second time will cut deeply."

On the other hand, conservation cuts waste. For example, insulation can decrease the wasteful use of heating oil. Over the long run, conservation can save money and increase energy efficiency. For example, it is possible to buy an air conditioner that is more efficient than another air conditioner of comparable size and quality. And the more efficient air conditioners often cost less than the less efficient ones! Even if initial costs are greater, more dollars will be saved in operating the more efficient model over a period of years. Consumers should carefully examine products with this in mind.

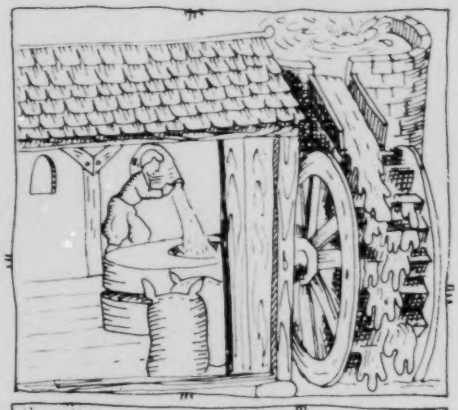
Conservation may eliminate some jobs, but at the same time, it can create new jobs. For example, decreasing the production of disposable bottles can lead to a decrease in the number of people required to produce the disposable bottles, while increasing the number of people who must collect and wash returnable bottles. Likewise, conservation through improved insulation can reduce the number of people needed to bring heating oil to homes, but at the same time, more jobs are created in the building industry.

However one may view conservation costs, it is clear that the cost consumers pay for energy conservation measures is worthwhile – the freedom and comfort of future generations will be assured. Though they can no longer be as wasteful, citizens can continue to enjoy a high standard of living.

*Taken from **Ideas and Activities for Teaching Energy Conservation,** Grades 7-12, by the University of Tennessee Environment Center, Knoxville, Tenn., chapters, "Historical Perspectives on Energy" and "Energy Conservation."*

HISTORICAL PERSPECTIVE ON ENERGY

About 400,000 years ago, people learned how to use wood to make fire for heat, cooking, light and protection.

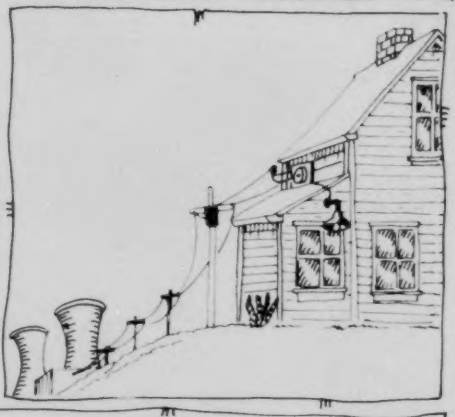


Water wheels were widely used by early civilizations. Water turned a wheel and helped people to do work, such as grinding wheat for flour.

Windmills were first used in Europe about 700 years ago. Since that time, both water wheels and windmills have been used to generate electricity.

By the 16th and 17th centuries, wood was becoming scarce in Europe. People began to turn to coal for energy. We were beginning to switch from renewable energy sources – the wind, water, and the sun – to non-renewable sources – coal, oil, natural gas.

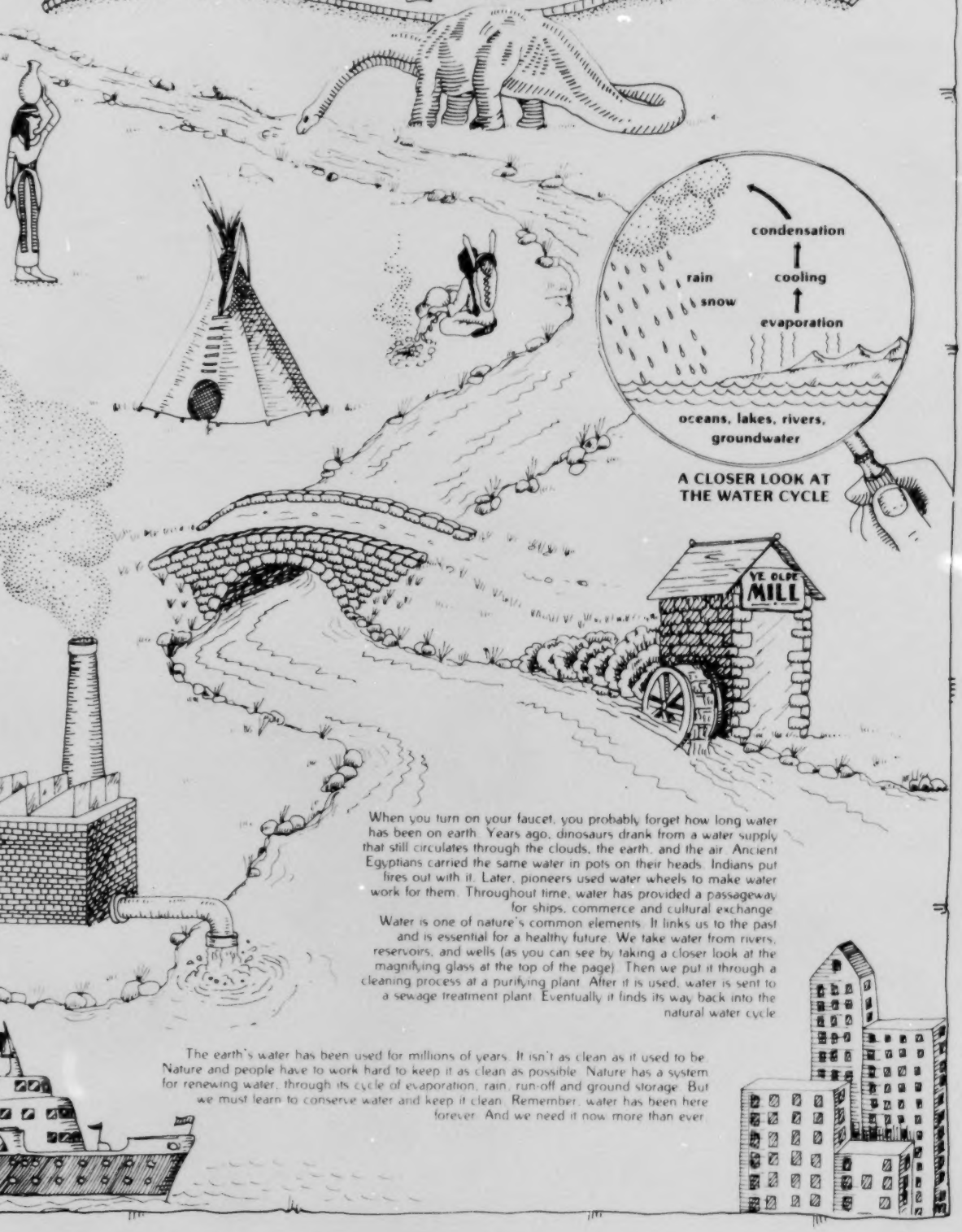
The Pennsylvania Rock Oil Co. first discovered oil in the 1850's. About 100 years later, petroleum and natural gas were widely used in the U.S. to heat homes, run factories, and generate electricity.



About 30 years ago scientists learned how to split the atom to create energy and generate electricity. Nuclear power now provides much of our electricity, but it also produces unsafe radioactive wastes. And non-renewable energy sources – oil, natural gas – are becoming scarce.

So we are again looking toward renewable sources – water, wood, the sun, the wind – to provide the energy we need.

A LOOK AT THE WATER CYCLE



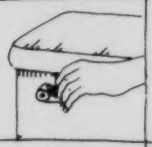
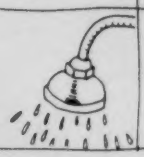
When you turn on your faucet, you probably forget how long water has been on earth. Years ago, dinosaurs drank from a water supply that still circulates through the clouds, the earth, and the air. Ancient Egyptians carried the same water in pots on their heads. Indians put fires out with it. Later, pioneers used water wheels to make water work for them. Throughout time, water has provided a passageway for ships, commerce and cultural exchange.

Water is one of nature's common elements. It links us to the past and is essential for a healthy future. We take water from rivers, reservoirs, and wells (as you can see by taking a closer look at the magnifying glass at the top of the page). Then we put it through a cleaning process at a purifying plant. After it is used, water is sent to a sewage treatment plant. Eventually it finds its way back into the natural water cycle.

The earth's water has been used for millions of years. It isn't as clean as it used to be. Nature and people have to work hard to keep it as clean as possible. Nature has a system for renewing water, through its cycle of evaporation, rain, run-off and ground storage. But we must learn to conserve water and keep it clean. Remember, water has been here forever. And we need it now, more than ever.

QUESTIONS TO ASK YOURSELF

1. Do you know where your water comes from? A nearby lake, river, or reservoir?
2. Is your water purified at a treatment plant before and after you use it?
3. How does nature clean water? Try and explain the natural water cycle and how it helps to purify water.
4. How much water do you use a day? How much water does your family use? Use this chart to figure it out.

Water used	Average ammount for each use	Times per day	Times per day X average amount for each use	(Times per day X average amount for each use) X (No. of people in your family).	Total
Example: (one drink of water)	1/4 gal.	4	1/4 gal. X 4 = 1 gal.	(1/4 gal. X 4) X (5 family members) = 5 gal.	
One drink, plus water run to get it hot or cold*	1/4 gal.				
Brushing your teeth once, plus water run to get it cold	1/4 gal.				
Washing your face or hands once	2 gal.				
Flushing the toilet once 	3 gal.				
Bathing	30 gal.				
Taking a shower 	20 gal.				
			Total:	**Total:**	**Total:**

FINAL QUESTION: Adding up the figures in the last column of the chart, how much water does your family use per day? Suppose that your family, or that you alone, could save 15 gallons of water per day. If each person in the U.S. could save this much, how much water could be saved each day? (Assume that there are 200,000,000 people in the U.S.)

* You probably would not drink 1/4 gal. of water every time you got a drink, but it would take about this much to get the water hot or cold.

THE HEAT LEAK DETECTIVE GAME

TOOLS

1) a draft detector made by taping plastic food wrap to a pencil.

2) a note pad and pencil to jot down clues and findings.

FIND THE HEAT LEAKS IN YOUR SCHOOL

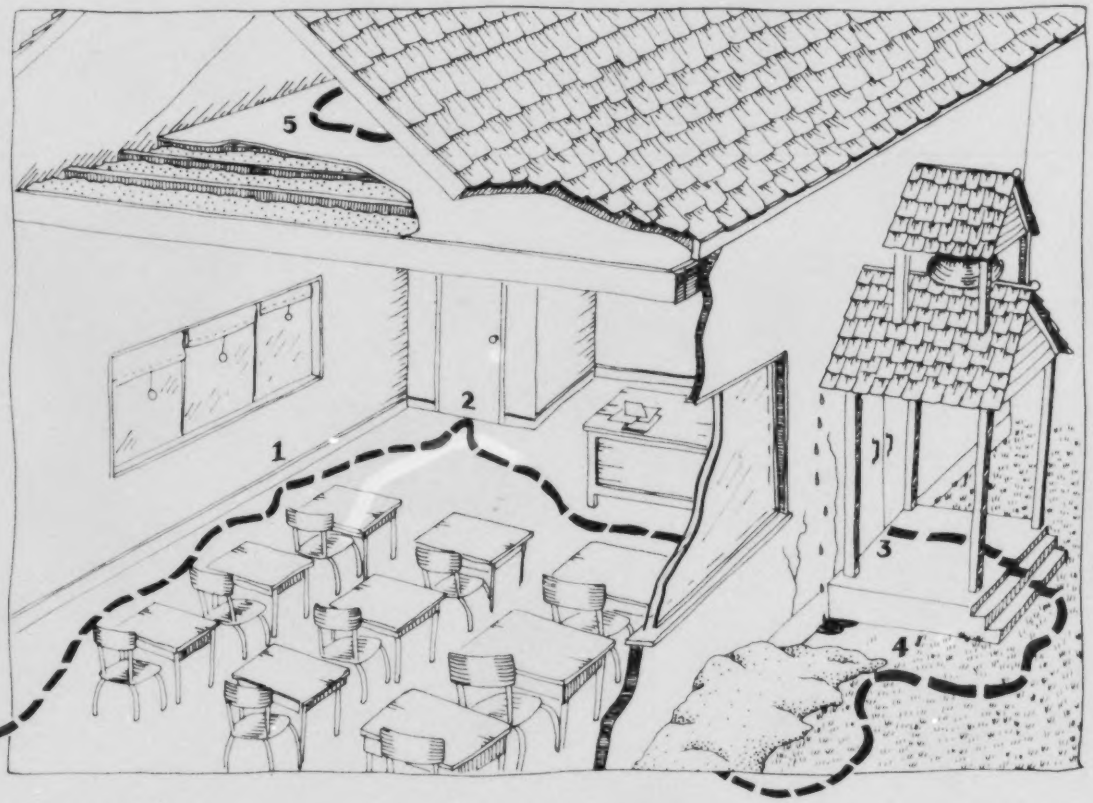
1) Search out drafts by holding the draft detector to probable leaks. Does the plastic move?

2) Write down the trouble spots and describe ways of plugging the leaks.

3) Return to class with your findings. Who in the class found the most leaks?

1 Curtain or Shades: Are curtains used at night to hold the warm air in? Could carpets or rugs contribute to keeping the air in?

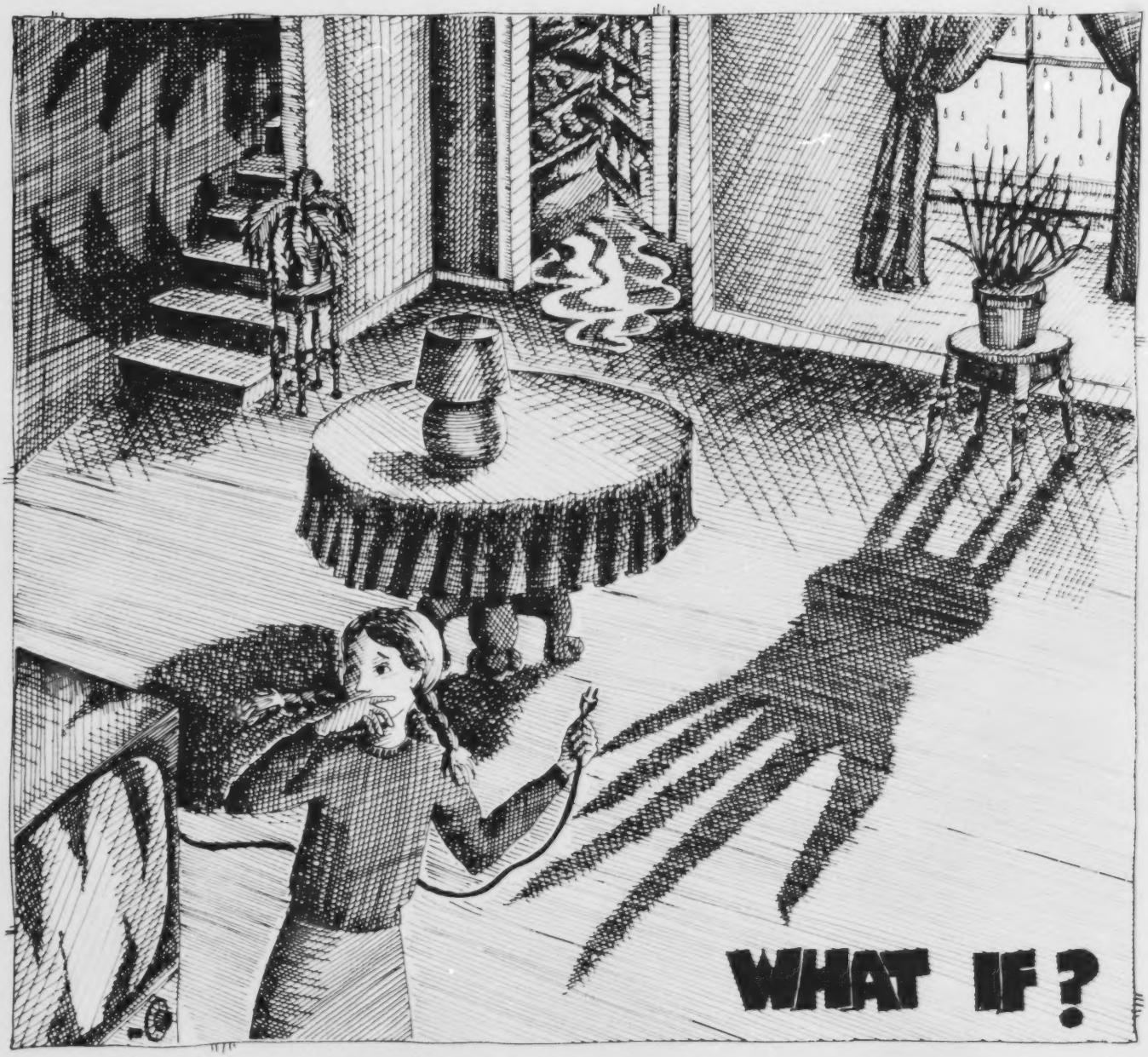
2 Storage Rooms and Closets: Are the doors of storage rooms and closets left open? Areas not commonly used need not be heated and should be kept shut off from other rooms. Do their doors fit tightly, or is heat leaking into them?



3 Windows and Doors: Are doors or windows left open for no reason? Is there weather stripping around doors, caulking around windows? Do the window frames fit tightly against the wall of the room, or is there heat escaping through cracks? Does the glass fit tight in the frame? Are storm windows used in the winter? Are double door entrances used, with each door kept shut when not in use?

4 Outside the School: Are there cracks in the brickwork or related breakage or disrepair in other construction materials? Earth piled against the wall can allow damp to penetrate the walls, requiring unnecessary heating. Is there water dripping or splashing against the wall? Do the windows and doors fit tightly from the outside?

5 The Roof or Attic: Is there insulation? Is the structure solid and closely fitted? Are there gaps or cracks in the material? Is there a structural air gap?



Imagine coming home from school one afternoon. It is a cold, rainy day. You walk in the house and it seems cold. No lights are on. You go to the refrigerator for a snack. The light doesn't go on when you open the door and the milk carton you take out doesn't feel very cold. You turn the television on, but there is no sound, no picture. You check the cord. It's plugged in. Soon you realize there is no electricity in your house; in fact, the whole neighborhood is experiencing a blackout. No one knows when the power will be restored.

Write a story describing what happened to cause the blackout and how the people in your neighborhood react to it. There will obviously be many disadvantages. Can you imagine any good things that could come from a blackout?

Quiz for Lesson Two

1. We use the term "Spaceship Earth" because:
   a) we have landed a man on the moon
   b) it shows us that everything on earth is limited
   c) it is the name of a television show

2. Name two fossil fuels and two renewable resources.

3. Name as many heat leaks as you can think of in your home. Tell what you would do to plug each leak.

4. List conservation methods used in your town.

LESSON THREE: TRANSPORTATION

Objectives:

Students should be able to assess the relative energy efficiencies of different transportation modes, and have an understanding of the role transportation played in their area's development.

Vocabulary:

energy efficiency
miles per gallon
caloric energy

Discussion of Concept:

1. **Shut Down by Tin Lizzie**: Read "Shut Down by Tin Lizzie" to the class. Have the students bring the story up to date by describing the role of transportation in the evolution of their community or area. (Refer to discussion suggested in resource material.)

2. **Rating Transportation**: Make a rating chart on the board to evaluate the kinds of transportation used in your area. A sample chart is given in the resource material. Let the students rate the modes for convenience and enjoyment. The more modes they can think of the better!

Materials Needed:

Beans for the Hare and the Tortoise Game

Class Activity:

1. **The Hare and the Tortoise Energy Game**: Read the fable to the students to refresh their memories if they are familiar with it, or to introduce it to them if they are not. You'll want to play this game in the schoolyard or the gymnasium (instructions found in the resource material). You might want to try different variations, using different forms of transportation. Or you might want to play the game more than once to give the students a chance to represent several modes of transportation.

Home Activity:

1. **How Much Does Transportation Cost?**

2. **Did Columbus Come on Mass Transit?**

Preparation for Next Lesson:

Bring materials for recycling paper (you might want to make pulp beforehand); gather materials for poster making; call ahead to recycling center to learn what materials they accept.

Today, the countryside of the Midwestern states is dotted with many once-thriving small towns, now little more than reminders of the vital role they formerly played in rural America. The advent of the automobile doomed them to the same fate as the mining town of the Old West when the ore ran out.

Prior to 1920, the horse-drawn vehicle and the railroad were the primary means of transportation. Most small towns were located from five to ten miles apart, usually along a railroad. They provided an essential initial stage in the flow of agricultural products to the markets of the large cities. Alongside the railroad tracks were usually a mill, grain elevator, and stock pens where farmers could market their cash crops and livestock.

A typical town in Missouri had a population of slightly less than 500 in 1920. It was a lively thriving trade center for people living within a radius of approximately five miles. It had two banks, two drugstores, six grocery stores, a furniture store, an undertaking parlor, a lumberyard, a livery stable, a blacksmith shop, a garage, three churches, and a hotel, in addition to the rail-side facilities mentioned above.

It also had its own school system from first grade through high school. No transportation was provided for the students. Those living beyond reasonable walking distance rode horses before the car became commonplace. Students from outside the school district (approximately two miles square) paid a monthly tuition. The town elected its own school board, voted, and collected taxes.

The average family living in a small town was landlocked. Its only means of travel to another point was by the railroad. It had no need for horses for work purposes and would not think of going to the expense of maintaining them for an occasional Sunday afternoon ride in the country. Adult residents of the small towns were work-oriented. Vacation trips and leisure were terms with which they were relatively unacquainted. The workweek consisted of six very long days, and Sunday was needed to rest up for Mondays. Consequently, there was practically no opportunity for leisure as we know it.

Between 1910 and 1920, the manufacture of automobiles underwent enormous growth. Previously, the automobile had been largely a novelty – a sort of plaything for the well-to-do. A number of things began happening almost simultaneously. Many people got into the business of today – like Ford, Dodge, Chevrolet, Buick, Oldsmobile, and Cadillac. Competition, plus the success of Henry Ford in producing a low-cost, practical car (the model T), placed automobile ownership within reach of the average family, leading to a dramatic change in American life.

Ford developed a simple design and the ability to mass-produce it at low cost. In addition, a simple financing system was adopted on the monthly installment plan.

The people responded with enthusiasm, and soon almost every family owned an automobile of some make or description. The availability of a car quickly modified old habits and attitudes. What was previously impossible

or impractical, suddenly became both possible and practical. The automobile made one-day recreational trips for town residents possible and provided the flexibility of going to the county seat or some other larger town or city without being dependent upon rigid rail schedules. In many instances, the round trip, between two towns only ten miles apart, could not be made by train without an overnight stop. Suddenly, such a trip could be made in less than one hour each way.

There was one drawback. The roads were designed for horse-drawn vehicles. They were dirt, or better stated, were mud when it rained. Anyone planning a trip by car, made it contingent upon fair weather. In summer, this might mean postponement of a needed trip for a day or longer, but in winter and spring, it was another matter. Sometimes, roads were impassable for automobiles for weeks. It was still the world of the horse.

The clamor for road improvement was great, and state legislatures responded. The 1920's saw tremendous road-building effort. All-weather roads were the objective. First, they were coated with gravel. It was the quickest and least expensive, but concrete and asphalt soon followed.

The combination of the car and the all-weather road meant death to the small town. The need simply ceased to exist. The farmer could go a dozen miles by car much easier and quicker than five miles by horse and wagon. So could the townspeople. The larger towns offered more services and more activity.

Today, the town mentioned above is a ghost. Its once-active business section has been reduced to one gasoline service station and a small grocery store. People still live in the houses that remain, but they are employed elsewhere. There is no longer a high school, for the automobile made possible the school bus. The bus, combined with the highways, brought consolidation of school districts. But more than schools have been consolidated. Markets, churches, community boundaries, social and recreational activities have all been affected. Just as an old washboard serves as testimony to the existence of a day before the electric washing machine, many small Midwestern towns stand as eroding monuments to the era before the automobile.

From the U.S. Dept. of Energy's* **Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy, "Transportation and the City" booklet for Grades 8 and 9. Developed by the National Science Teachers Association.

Class Discussion

Have the students bring the story up to date by describing the role of transportation in the evolution of their community or area.

Students in rural areas may see strong similarities between their town and the town described. Was their town built on a railroad line or a dock? Do they drive to a larger town for supplies? How have Interstate highways affected the economies of small towns they by-pass? How will gasoline shortages affect their town? Have the students determine an end to the story.

Students living in a small city should look at transportation situations and problems unique to their area. Their town probably has thrived because of "Tin Lizzie." Now automobiles may contribute to a congestion problem. Is mass transit available in their town? Is it used to its potential? If not, why? Can they walk or bicycle many of the places they are going? Has their city gone for strip development?

Discuss the automobile's role in the development of shopping strips and suburban shopping malls. Is this the "end" of the story? Consider rising costs of gasoline as well as shortages of fuel and have the students develop another end for the story.

Suburban students should discuss their area's dependence on the automobile. Do their parents have a choice in how they get to work? Can they car pool or catch a bus or subway? "Tin Lizzie" made possible the suburb, modern day's small town. Discuss the differences between the small town in the story and the suburb today in terms of transportation required. How will gas shortages change their area? Follow the changes through to the end of the story.

Students in urban areas should look at the way their cities have developed. When was mass transit first used? Why was it used and is it as important a transportation form now as it was, say, at the turn of the century? How will rising costs affect the bus and subway systems in their city? Have the students follow the trend for their city through to end the story.

Rating Forms of Transportation

Ask the students to name the kinds of transportation available in their area. Draw a chart on the board to rate each form of transportation in terms of cost and energy efficiency, convenience and enjoyment.

Energy Efficiency: Base this on the passenger miles per gallon ratings given in the Hare and Tortoise game. As in the game, the figures used in the chart below are a tenth of the rated passenger miles per gallon given for each mode of transportation. The chart below also shows rough estimates for energy efficiency in human and renewable transportations based on the passenger miles per gallon for walking and bicycling. You might want to devise your own numbering system.

Enjoyment and Convenience: Use a 1-20 rating system for enjoyment and convenience. Convenience is a measure of accessibility and time required to reach the destination.

Human, Renewable and Fossil Fuel Power: Human power is renewable power, of course, but we will make the differentiation here to enliven the comparison. Examples of human power might include: roller skates, bicycles, skateboards, canoes. Examples of renewable power: sailboats, a horse-drawn sled or wagon, a car that runs on alcohol or gasohol, a vehicle powered by water or from electricity produced by a renewable resource. You might want to point out that more than 50 percent of the energy used for transportation in our country is used in automobiles and that nearly all our main modes of transportation require petroleum as fuel. Briefly explain the economic problems of importing oil (i.e., inflation, rising energy costs) and the environmental problems associated with fuel exhaust. Compare these problems to problems associated with other modes of transportation and discuss with the class the advantages and disadvantages of each mode.

Total the numbers. The students should make comparisons and then suggest a course for the future. Here is a sample rating chart:

TRANSPORTATION			ENERGY EFFICIENCY	CONVENIENCE	ENJOYMENT	TOTAL
Fossil Fuel	Renewable	Human				
car			2	17	14	33
	sailboat		40	5	17	62
		roller skates	35	7	15	57
plane			2	19	16	37
	horse-drawn wagon		25	8	12	45
		walking	45	5	10	60
bus			9	12	9	30

Mode of Transportation	Passenger Miles per Gallon	Average Estimated Speed
Plane (commercial jet)	**18**	**350 mph**
Rail	**65**	**40 mph**
Automobile (intermediate size)	**24**	**55 mph**
Subway	**60**	**45 mph**
Motorcycle	**60**	**35 mph**
Bus	**90**	**25 mph**
Walking	**450**	**3 mph**
Bicycling	**756**	**5 mph**

Set out a race course in a gymnasium or playground with a start and finish line. The course should be about 30 yards long. (Roughly based on the probable length of the bicycle's course because the bike has the best energy efficiency and will be traveling the greatest distance.)

Students can choose what form of transportation they want to represent. Energy beans should be allotted according to the estimates below (based on passenger miles per gallon). Because there is such a gap between the walker and the bicyclist and other forms, the proportions have been adjusted to fit the game. Also represented below are the speeds of the different transportation modes. Explain to the students that each form of transporation will move on the course in strides, leaps, hops and skips that represent average speed.

Automobile	**2 beans**	**running leaps**
Subway	**6 beans**	**long strides**
Motorcycle	**6 beans**	**skips**
Bus	**9 beans**	**hops**
Walker	**25 beans**	**casual strides**
Bicyclist	**40 beans**	**pedals (each pedal take 5 beans) or use 40 medium strides**

Each student will get one leap, stride, skip or hop for each energy bean. The car has the highest average speed, but it only gets 2 energy beans, so the car takes two running leaps. The subway moves ahead at a slower rate with 6 long strides. The motorcycle runs at 25 miles an hour with the same energy efficiency as the subway; it gets 6 skips. The bus takes nine hops; the walker 25 strides, the bicyclist 8 pedals or 40 strides.

The game can be played with each transportation taking its turn consecutively, or the students can act out their form of transportation simultaneously and the game becomes a race in the true sense of the word. Either way, the energy efficiency of the different modes should be clearly demonstrated, with the steady turtle again winning over the wily rabbit.

Passenger miles per gallon figures taken from* **Energy Primer: Selected Transportation Topics, U.S. Department of Transportation Sharing Program. The figures for walking and bicycling are from Statistical Abstract (1970) for 1965 and Automobile Facts and Figures (1971).

A Hare one day ridiculed the short feet and slow pace of the Tortoise, who replied, laughing: "Though you be swift as the wind, I will beat you in a race." The Hare, believing her assertion to be simply impossible, assented to the proposal; and they agreed that the fox should choose the course and fix the goal. On the day appointed for the race the two started together. The Tortoise never for a moment stopped, but went on with a slow but steady pace straight to the end of the course. The Hare, trusting to his native swiftness, cared little about the race, and lying down by the wayside, fell fast asleep. At last waking up, and moving as fast as he could, he saw the Tortoise had reached the goal, and was comfortably dozing after her fatigue.

Slow but steady wins the race.

...an Aesop Fable

The Hare and the Tortoise Energy Game

The ancient fable of the race between the tortoise and the hare will find new life in this game as students representing different modes of transportation find themselves in a similar situation in a race to the finish line.

Two factors are important in the game: the energy efficiency of the different modes of transportation and the average estimated speed of each. Students will receive energy beans representing fuel efficiency, based on passenger miles per gallon. A race course will be laid out and each of the six different modes of transportation will be represented by one or more students. The speed of the vehicles will be graphically illustrated by running leaps, hops, skips and casual walking steps. The class will find that the automobile is the Hare of the transportation field. The bicycle will be the Tortoise, slow but sure and the ultimate winner.

If you like, make construction paper or cardboard cut-outs of a car, a subway, a motorcycle, a bus, a walker and a bicyclist. On each put the average estimated speed. Divide the class into the six areas of transportation. Pin or hang the representations on the students and explain that they will get energy beans according to their transportation's energy efficiency. You might want to further explain that the efficiency is based on passenger miles per gallon (as listed on the chart on the folllowing page) and that walking and bicycling are based on the needed caloric energy, or the food a person needs to eat to have the required energy to walk or bicycle a certain distance.

How Much Does Transportation Cost?

Imagine there are 20 people who are taking a short trip to town. The total distance, coming and going, for the trip is five miles. Each of these people owns a car that goes 20 miles on one gallon of gasoline. A gallon of gas costs $1.25.

If each person drives alone on the five-mile trip, what is the total amount of gasoline that would be used? _____

How much would the gasoline for the 20 separate trips cost? _____

How much gas would each person use? _____

How much would each person spend? _____

Let's say only half the cars made the trip to town. Two people are riding in each car to save gas.

How much gasoline would be used in the 10 trips? _____

How much would the gasoline cost? _____

How much gas would each person use? _____

How much would each person spend? _____

What if four people decided to go in one car? _____

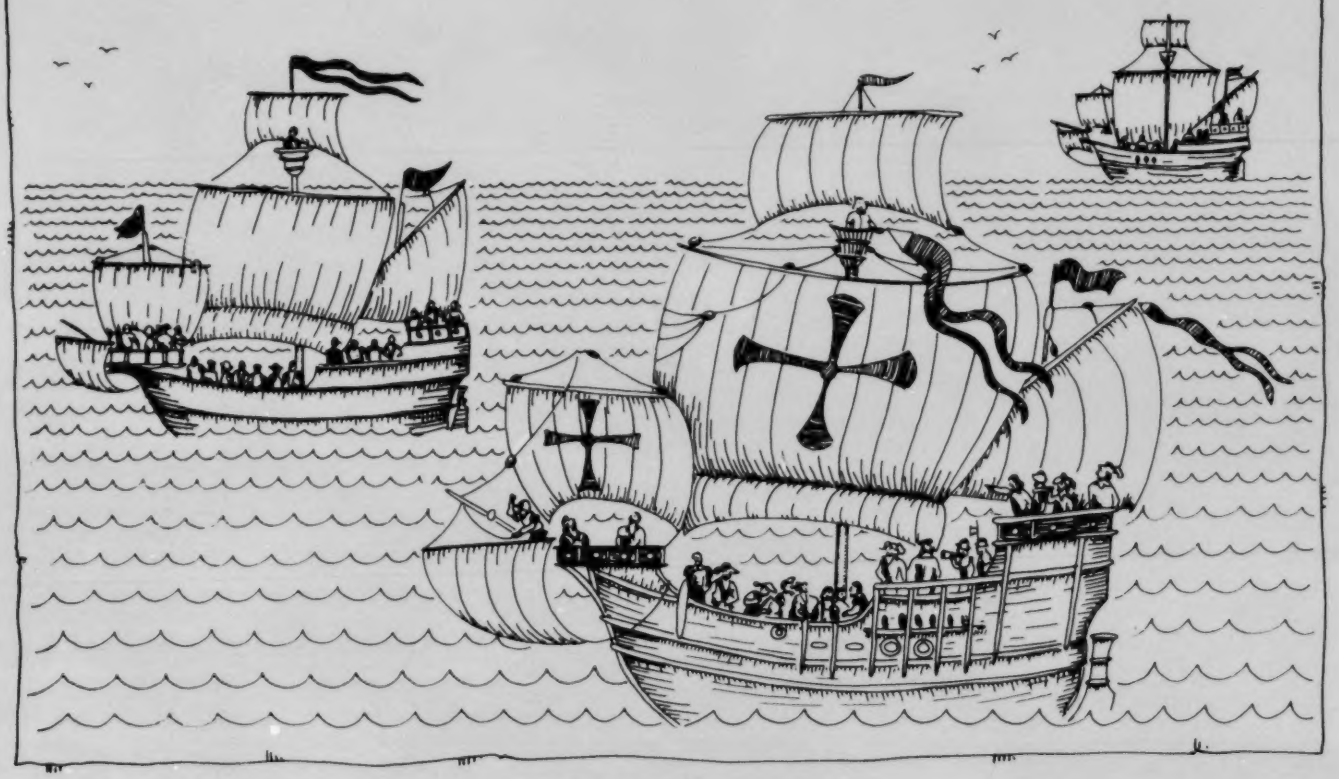
How much gasoline would be used in the five trips? _____

How much would it cost? _____

How much gas would each person use? _____

How much would each person spend? _____

DID COLUMBUS COME ON MASS TRANSIT?



Think of a form of mass transit used in historic times. The further back in history you can go, the better. Examples might be: the electric streetcar, the covered wagon, the ships that brought the pilgrims to America, the gondolas in Venice.

Read and research what you can about that form of transportation. Write a short report that explains how that form of transportation reflected the time it was used in history.

Did it contribute to changing the times? How?

Did it change, in any way, the way people lived? What were the changes and how important were they?

Did this form of mass transit contribute to our way of life now? How?

Quiz for Lesson Three

1. What mode of transportation is the most energy efficient?
   a) the subway
   b) a commercial airplane
   c) a car

2. Rate the following in terms of importance when judging energy efficiency in transportation:
   a) speed
   b) size of vehicle
   c) amount of fuel used per mile
   d) convenience

3. Describe two ways changes in transportation have changed your town.

LESSON FOUR: A LOOK AT WASTE

Objectives:

Students should be able to name the materials that are recycled in their area, as well as several materials and resources that could be recycled, but aren't.

Vocabulary:

recycling
solid waste
"Throw-Away Society"

Discussion of Concept:

1. **Historical Perspective of Waste**: Using the resource material, discuss waste in an historical perspective, noting the roles played by a growing population, increased use of fossil fuels, industrial development and the carelessness of a "Throw-away Society." Discuss waste in terms of limited resources and environmental pollution. Discuss the material covered in "Our Heritage in Papermaking."

2. **What Can You Recycle?**: Ask the students to name the items that can be taken to their local recycling center. Complete the list. Give examples of other things that can be recycled (refer to introductory material for creative examples). A local example would make for a good discussion. Ask the students to name things used in their homes that have been recycled (examples: fabric scraps for quilts, food and manure for compost, coffee cans, refrigerators for smoking food, containers for food storage, clothes, etc.)

Materials Needed:

For paper recycling project: wood frames, screen, blender, waste paper, newsprint, sponges, masking tape, large wash basins, water, felt.

Class Activity:

1. **Making Recycled Paper:** Demonstrate steps to the class; divide the class into groups. The larger group will make posters; splinter groups from the poster-making group will come at intervals to the wash basins to participate in the paper making.

2. **Poster Making:** The class can make posters announcing the trip to the recycling center the next week. The posters should invite the rest of the school to participate in the effort by bringing recyclable material to school for the class to take to the center. List the items on the poster that the center will accept.

Home Activity:

1. **Home Wastes:** Have students make a list of five items that are discarded in their homes before they have been fully used. Ask them to write a short report on what could be done to get better use of wasted food and materials.

2. **Items to Recycle:** Have students collect items for recycling center.

Preparation for Next Lesson:

Arrange for a field trip to the recycling center or the city dump, or to another place where conservation and recycling are the focus of activity.

Man in the Environment

Man began as a simple omnivore who gathered fruits, nuts, and seeds; who killed and ate animals smaller than himself – and was then prey for the larger carnivores. He was an integral part of a functioning ecosystem. He was a part of the web of life – of no more importance than a plant, a bird, or a fish. But that was earliest man.

As man developed into an agriculturalist, he began to have more impact upon his environment than the other animals around him. He disturbed the soil, transported and distributed seeds, and diverted water for irrigation. His impact was still light, but increasing.

Although man appeared on earth well over a million years ago, his populations increased almost imperceptibly until he became a farmer – but the increase began to be noticeable. Even then, human populations amounted to only about a quarter of a billion by the beginning of the Christian era. By 1820 the world contained a full billion – and only 110 years later, in 1930, another billion had been added. Only 30 years later, in 1960, there were three billion people on earth and in 1976 there were four billion. It is predicted that by the year 2000 the population will exceed six billion.

As human populations increased, human needs increased to the same degree. Man needed more plants and animals for food, clothing, shelter, and warmth. And, as he became a tribal or communal animal, man began to develop wants as well as needs. When one superior man developed a bow and arrows, or a better stone axehead, other men wanted the same for themselves.

In more modern times, needs have increased faster than populations because a more complex society creates more needs – but man's wants have increased exponentially. This formula of increased populations times greater needs, times increasing wants, has put stress upon natural resources. The procedures of harvest and processing of these resources have created additional impacts upon the environment. Man's technology may supply needs, but it also creates wants, and these same technological processes can interfere with natural cycles and systems.

Certain parts of the natural environment are irreplaceable. Living resources are renewable; plant and animal resources are renewable – but can be destroyed. And with their destruction comes interference with natural cycles such as the carbon, water, and oxygen cycles. No life on our earth can exist without these systems.

Concentrations of human populations often lead to environmental deterioration. When man lived in family groups he was forced to move from time to time because he had harvested the plant and animal resources to a level where it became difficult to feed himself. But he was also forced to move when the accumulation of his wastes became unbearable.

Modern, metropolitan man brings resources from the far corners of the earth and builds permanent dwellings. He finds it difficult to move – and his wastes have become a major environmental problem. Not only does he have the scraps from his table and his body wastes to dispose of, but also quantities of effluent from his technology which become increasingly difficult to dispose of. Such materials as radioactive wastes, industrial chemicals, and pesticides or herbicides are difficult to dispose of in a safe and proper manner. In some cases the technology for disposal has not been developed.

The masses of daily waste – garbage, rubbish, and industrial trash – have become burdensome in quantity. A quality environment can no longer be sustained when these wastes and by-products are dumped into rivers, lakes, and oceans or hidden in land-fill dumps where their leachings create further problems.

Our very complex society promotes conflict between man's needs and wants, and the quality of the environment. Almost anyone living in this country must have transportation in order to get along. So, at the present time, and automobile may be classed as a need – yet automobiles are the major contributor to air pollution in urban areas. Other forces, manufacturing and advertising, push to sell more, bigger, and newer cars in order to keep employment up and for the stockholders' invested money to bring reasonable returns. None of these things are wrong – it is important that people can receive a return on their investments, or there would be no money available for medical research, education, or other important social needs. It is important that the factory hums – because hundreds or thousands of people depend upon it for a livelihood. But there are conflicts between the needs for transportation, the desires for newer and bigger cars, and a livable environment.

Modern man's consumptive practices and patterns are constantly changing. Items once made of wood are now made from petrochemical-based plastics; steel and iron are replaced by aluminum or magnesium; and the volume of materials processed increases exponentially. Newer models are available yearly – with intensive promotion of the idea that "newer is better." We have been called a "throwaway society" – we are certainly a wasteful society – and the rest of the world seeks to emulate our lifestyles.

How can we plan for the future availability and use of oil? Should we continue to use petroleum as a source of energy, or, in the long-term best interests of mankind, should we conserve this limited resource for its uses in medicine, agriculture, certain plastics, the lubrication of essential machinery, or other, carefully chosen uses? Can we continue to increase our uses of wood products from limited forests – or should we develop a massive recycling of used materials into the system?

If man is to reduce the drain upon finite natural resources and to reduce the environmental impacts, there must be long-range planning not only to meet the natural resource needs of future generations, but to assure a healthy environment for ourselves as well as the future. Such planning, to be effective, must include not only scientific, but social understandings, and must proceed toward particular objectives.

Economics alone should not be the criteria for resource use and management. Perhaps some decisions will not be economically sound – we must be willing to pay the differences...

Increased populations, the concentrations of those populations, and current life-styles have contributed

significantly to a massive increase in per-capita waste. Man is literally being inundated by his own waste.

In 1900, each American used an average of 58 pounds of paper per year; by 1973 this figure had increased to 639 pounds per year. In 1970, 5.3 pounds of solid waste were produced daily by each man, woman and child in our country. By 1980, that waste is projected to be 8 pounds per day. This amounts to over 387 billion pounds of solid waste produced each year. If this waste was equally distributed over Arizona, it would bury the state to a depth of 7 feet in a single year.

What do we throw away? A typical ton of waste in the U.S. contains approximately 920 pounds of paper products; 440 pounds of food and yard wastes; 200 pounds of glass; 160 pounds of metal; 140 pounds of wood, and 140 pounds of cloth, rubber, plastic and leather.

To decrease the amount of solid waste that man generates may require modifications of individual and cultural value systems and individual lifestyles. Such changes may not be feasible. A practical approach might be to accept increasing amounts of solid wastes and concentration on methods of utilizing waste in a productive manner. Waste materials cannot be thrown away – Dr. Barry Commoner has reminded us that "there is no such place as away." The materials go somewhere and have a variety of effects upon our environment.

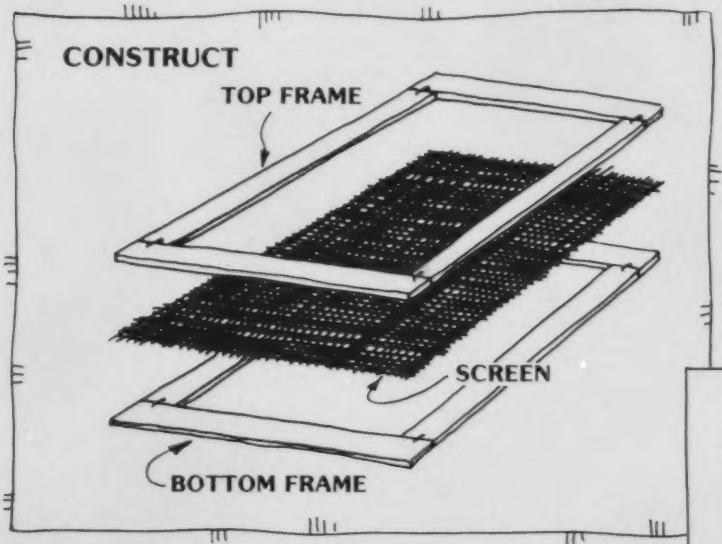
The ideal situation would be a two-fold approach to the problem – a modification of value systems and an intensification of recycling and reuse of all waste. Today's recycling of aluminum, glass, tin, and paper are only beginnings. The future must bring a recycling and reuse, in some form, of all waste.

*From: **Teachers' Resource Guide for Environmental Education**, Arizona Dept. of Education.

Helpful Hints in Making Paper

1. To save time, most of the pulp can be prepared the night before. If you make it much in advance, it should be refrigerated or it will ferment.
2. Using a few strips of colored construction paper makes the pulp prettier. Don't try to use dyes as they are messy and harder to work with.
3. The ratio of pulp to water is crucial. Experiment with it ahead of time by making a few sheets for yourself. The ratio is about 2 cups water to 1/2 cup shredded paper.
4. Pulp should be distributed on screens as thickly and evenly as possible before the screen is tilted to wipe off excess water. It will be easier for the students to pull the new paper off the screen if the pulp is about 1/16 to 1/8" thick.
5. Newly made paper should be left to dry on newsprint for a few days. Student's names can be marked beside their pieces of paper if they want their own.

HOW TO MAKE RECYCLED PAPER

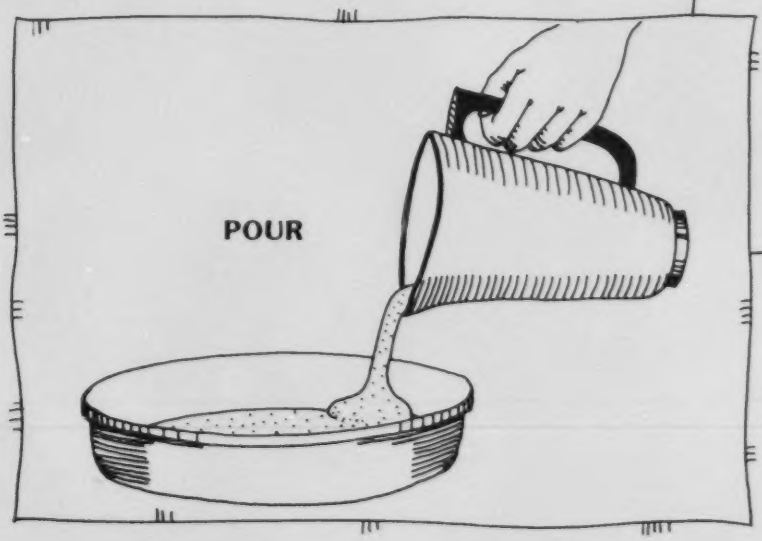


1 FIRST YOU NEED A FRAMED SCREEN, LIKE THIS:

Use thin pieces of wood to make the top and bottom frames.
Staple the screen to the bottom frame only.
Staple corners of wood frames together on top and on bottom.

2 THEN, YOU NEED THE PULP:

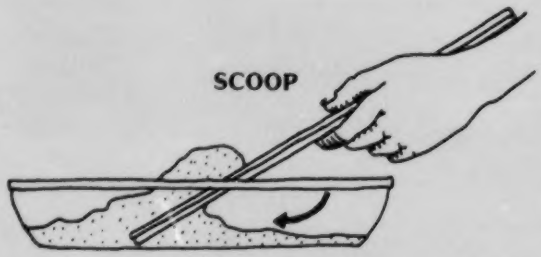
A quick way is to tear up some waste paper into tiny peices, put it in a blender and add a little water. About 1/2 page of newspaper will do. Add 1 T of cornstarch for strength.



After this is thoroughly blended to a pulp, pour it into a tub or pan, large enough to dip the screen into.

Pulp should be like split pea soup.

3 NOW COMES THE HARD PART:

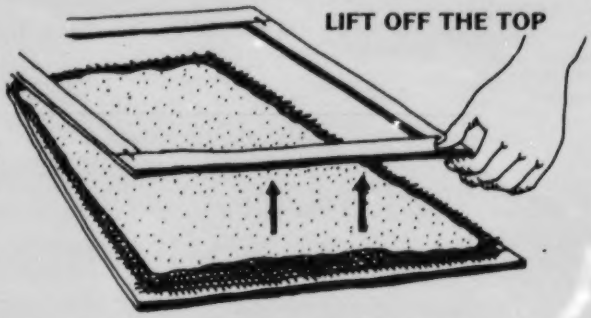


DRAIN

You have to scoop up the pulp out of the tub with the framed screen so that most of the water drains out. Make sure the pulp is on evenly.

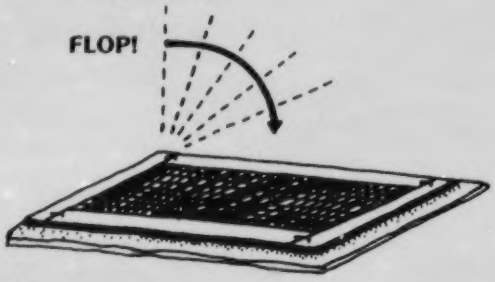
Next, tilt the frame up and wipe off the bottom of the screen to give it a smooth finish and to get out excess water.

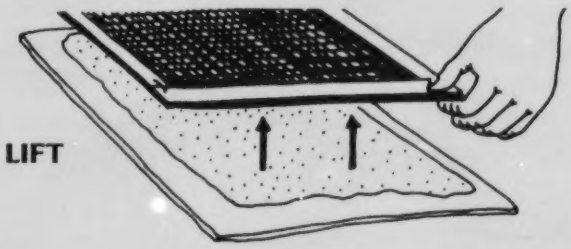
LIFT OFF THE TOP



Lift off the top frame, but be extra careful not to break the edges of the pulp.

Flop the bottom frame and screen over onto a white felt square and press down with another piece of felt to get out more water.





Now carefully lift the screen off. Take the paper over to newsprint and peel off the felt. Leave paper for 24 hours.

Recycling: Our Heritage in Papermaking

Today there is much discussion about recycling. In the seventies, recycled paper is an attractive alternative to wood fiber in making paper. Actually, the process of recycling is not new to the manufacture of paper in the United States. During the early colonial days paper was made from old clothing!

Paper is often referred to as the "handmaiden of civilization." It is vitally important in the field of knowledge as a keeper of records and as a medium for communication. The degree of civilization of a country may be measured by the amount of paper consumed. It is hard to imagine being without paper. The tools of the financial industry rely on paper. Consider not having paper money as a means of exchange. Also, industry and government would be unable to operate without paper.

History of Paper

Invented by the Chinese in 105 AD, paper gets its name from papyrus, a reed that the early Egyptians used for making writing material. Papyrus stalks were cut into thin slices and pressed into sheets. The Chinese later found that paper could be made by pounding rags, hemp, old fish nets and the inner bark of the mulberry tree into a fibrous pulp. These fibers were then matted into sheets and dried.

The Chinese art of papermaking spread to other parts of the world through the Middle East. Europeans started manufacturing paper in the 12th and 13th centuries. At the end of the 16th century, England was manufacturing paper in large quantities and supplying the needs of the American colonies.

By 1690, the increasing demand for paper in America led to an establishment of a paper mill in Philadelphia to produce writing paper. The primary raw material was discarded clothing – old rags – which was recycled to manufacture paper.

During the 19th century, several new developments changed paper manufacturing. Paper machines were invented to make paper in continuous rolls and wood fibre began to replace old rags as the primary source of material. With lower manufacturing costs, the demand for paper increased markedly. As a consequence of these events, recycling became less important to the paper industry.

Recycling Paper Today

Recycling today is again vitally important both from an economic and environmental standpoint. The rising costs of harvesting our forests, a growing accumulation of garbage and higher energy costs make paper recycling an attractive economic alternative. When you recycle waste paper, instead of throwing it away, you help conserve resources and protect the environment.

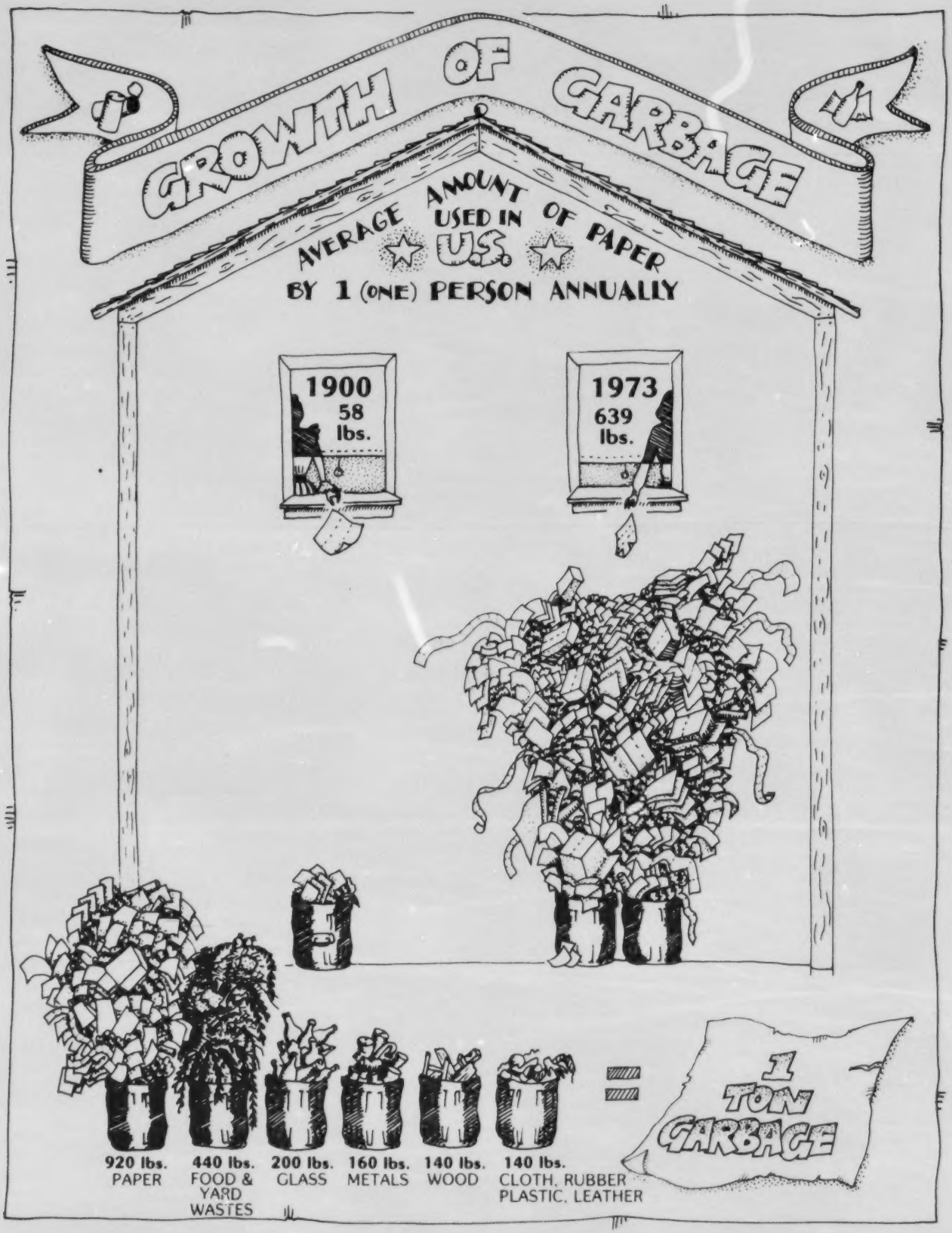
The first link in the paper recycling process is you – the individual who separates and saves waste paper. The collection of commercial quantities of waste paper is the second link. Fibres International, a modern waste paper processing facility located in Bellevue, Wash., is an example of this second process. Here, waste paper collected from businesses, from individuals delivering paper to the plant, or from groups conducting paper drives, is processed and supplied to recycling mills – the third link in the chain. Mills process the old paper into new and attractive paper products which come back to you – the first link in the chain. And so the cycle continues.

Some typical types of waste paper used in the recycling process include old newspapers, computer printouts, old corrugated containers, and tabulating cards.

Why Recycle Old Paper?

- Recycling old paper uses 50 percent less energy compared to making paper from trees.
- Each ton of paper that is recycled replaces and preserves an acre of harvestable trees.
- The recycling of paper reduces waste and garbage pollution.
- Recycled paper makes strong, attractive, and inexpensive packages.
- A recent survey indicated people prefer recycled packages because they help the ecology.
- Recycling helps school groups make money for travel purposes, purchasing new equipment, or donating to charitable causes.

** From "Old News is Good News for Schools," Fibres International, 1533 120th Ave. N., Bellevue, Washington.*


GROWTH OF GARBAGE
AVERAGE AMOUNT OF PAPER USED IN U.S.
BY 1 (ONE) PERSON ANNUALLY
1900
58
lbs.
1973
639
lbs.
920 lbs.
PAPER
440 lbs.
FOOD &
YARD
WASTES
200 lbs.
GLASS
160 lbs.
METALS
140 lbs.
WOOD
140 lbs.
CLOTH, RUBBER
PLASTIC, LEATHER
=
1
TON
GARBAGE

Each ton of paper that is recycled replaces and preserves an acre of harvestable trees.

The recycling of paper reduces waste and garbage pollution.

Recycling old paper uses 50 percent less energy than making new paper from trees.

Quiz for Lesson Four

1. Name the materials that the recyling center in your area accepts.

2. The best definition for recycling is:
   a) taking bottles and newspapers to the recycling center
   b) riding a bike around in a circle
   c) finding a new use for something that has been used.

3. From the turn of the century to 1973 the average amount of paper used by each person in the country
   a) doubled
   b) increased by more than 10 times
   c) tripled

4. The first recycling project in history
   a) recycled paper from old newspapers
   b) recycled old clothing to make paper
   c) recycled bottles

LESSON FIVE: RECYCLING

Objectives:

Students should be familiar with the rates paid in their area for recyclable items and be able to identify various wastes in their area that could be recycled to the economic and social benefit of the community.

Vocabulary:

industrial waste
bio-mass
compost

Discussion of Concept:

1. **Getting Cash for Trash:** Make copies of "A Very Short History of Trash" and pass them out to the class. Discuss the major points. Point out current obstacles to recycling. Note the recyclable material that currently is not being recycled in your area because of economics; compare to the hidden costs of waste: pollution, finding a place to bury or dump it, careless use of limited resources.

2. **Reports on Home Waste**: Discuss the students' findings. What is the most common area of waste? What items that can be recycled aren't? Do we often have a choice between a recycled container and a throw-away? What one material would the students choose to recycle that is not being recycled now?

3. **Industrial and Agricultural Waste**: Discuss industrial wastes in your community or area, such as by-products from manufacturing, wood ends from lumber mills, manure from stockyards, steam loss from a factory. Ask the students if they can think of a use for the waste or a by-product. (Examples: composting, bio-conversion)

Materials Needed:

Recycled paper from previous lesson

Class Activity:

1. **Field Trip to a Recycling Center**: Collect all the recyclable material and sort it properly (following instruction from the center). Visit the center with the students, having arranged in advance a time when a knowledgable person can discuss the economics of recycling. Ask where recyclable material is sent; how it is processed; what its next use will be.

2. **Field Trip to the City Dump**: The dump is an ideal spot to demonstrate needless waste. Have the students interview the person in charge. What items are most likely to find their way to the dump? Have they usually been fully used? Have students think of another use for one item they see at the dump. Give a prize for the most creative, workable idea.

Home Activity:

1. **Take Home Exercise**: Have students do exercises in "Do Returnable Bottles Save Energy?"

2. **Use the Recycled Paper:** Ask for volunteers to use the recycled paper for a poster or display for the classroom, or give interested students small sheets of the paper to make cards for an upcoming holiday.

Preparation for Next Lesson:

Gather art supplies for class activities you plan to do; you'll need beans or chips for the Energy Chain Gang.

A VERY SHORT HISTORY OF TRASH

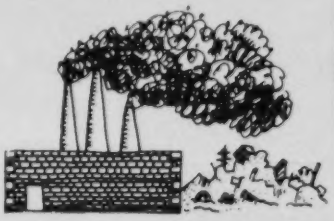
1 People have always had trash. Only Cavedwellers didn't have a big problem with it. In those days, there was plenty of room for trash. And nature easily disposed of it.

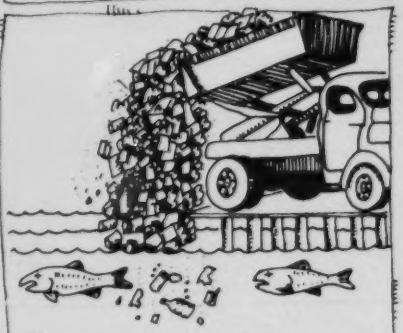
2 Today, trash is a big problem. More people mean more trash and more different kinds of trash. You name it – cans, paper, bottles, garbage, old cars, old clothes. In time it becomes T-R-A-S-H.

3 Every year, each one of us throws away almost ONE TON of trash. If you piled this trash in your living room, it would come to your shoulders.

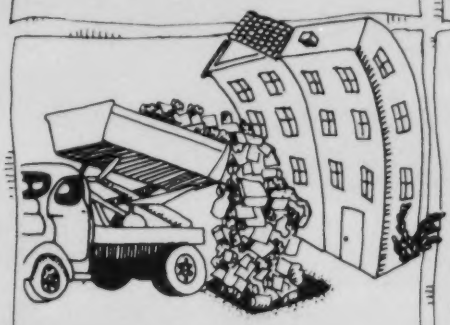
4 In one year, all our trash amounts to 360,000,000 tons. We have problems with trash that Cavedwellers never had. To get rid of it, we have tried to...

5 ...burn it. But burning trash can cause air pollution.





6 ...dump it in the ocean. But dumping can pollute the ocean, too.



7 ...bury it. But we're running out of empty land near cities.

8 Some scientists have even suggested shooting it off into empty space. But who wants old tennis shoes and pop cans orbiting the earth?

9 In the past few years, however, we have found a new way to get rid of some of our trash. It's called RECYCLING.

Recycling means reusing our trash instead of getting rid of it. This solves the problem of what to do with our trash and it also helps us with another problem. By using the same materials over and over again, we save our natural resources.

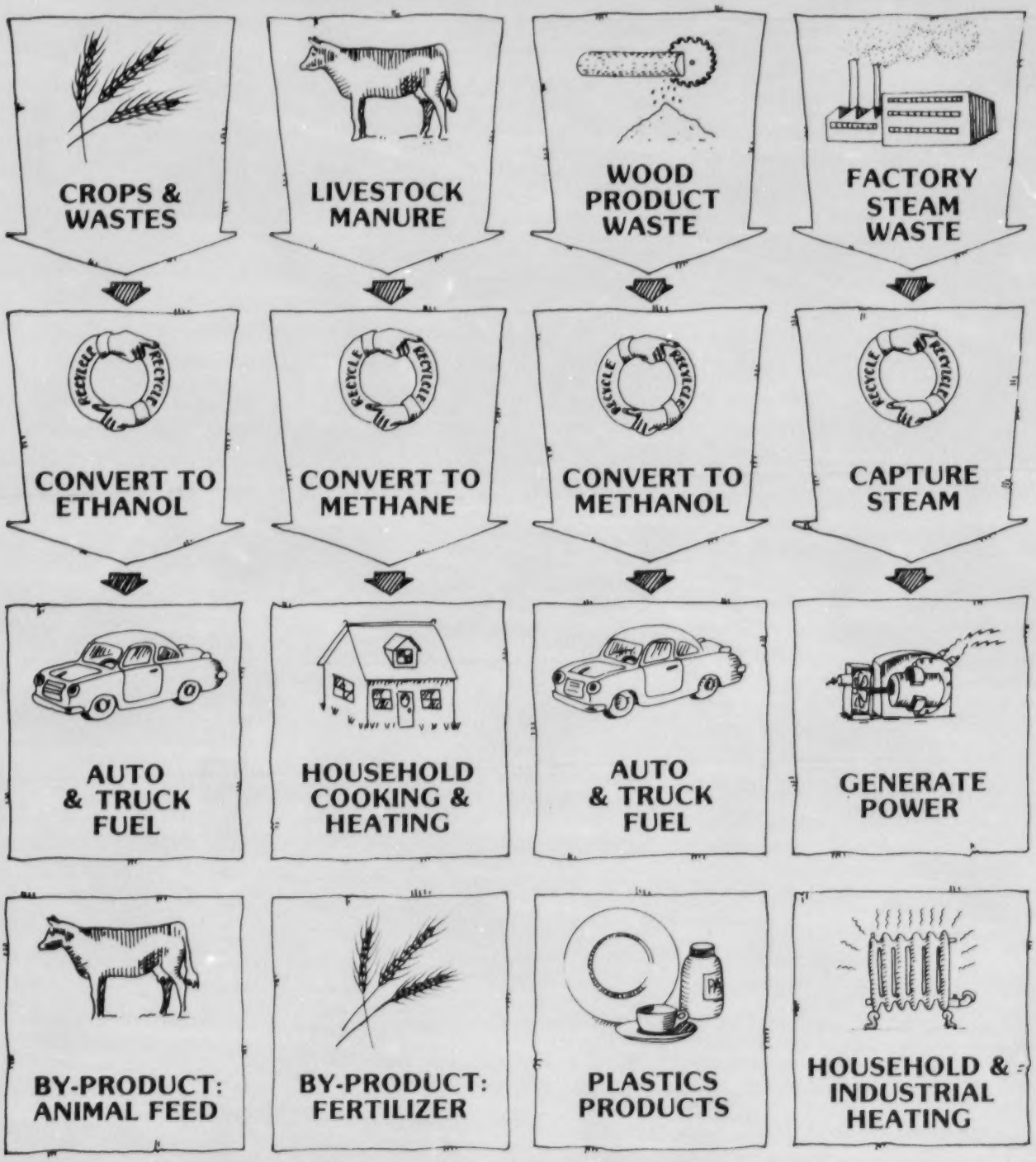
Recycling means shredding old cans and cars and melting the pices to make new metal for new cans and cars...

...chopping up grass cuttings and garbage to burn for energy or to make fertilizer to help new plants grow...

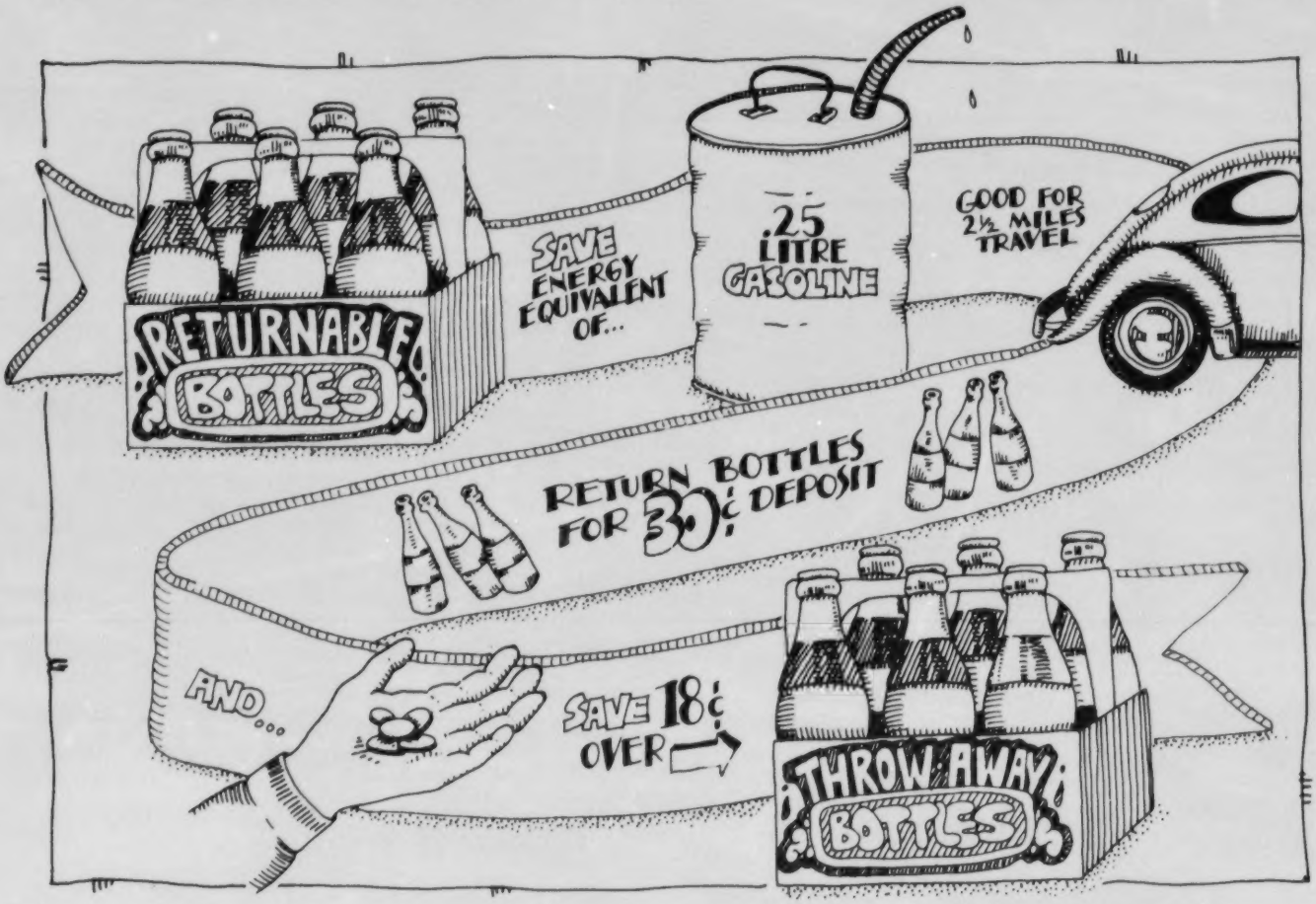
...crushing bottles into tiny glass bits and melting these bits to make new glass.

* *Concept provided by McDonald's Corp.*

INDUSTRIAL & AGRICULTURAL WASTES



DO RETURNABLE BOTTLES SAVE ENERGY?



The purchase of a six-pack of soft drinks in returnable bottles instead of no-deposit no-return containers will save the energy equivalent of .25 liters of gasoline. The saving of .25 liters of gasoline can take the average family car about 2 ½ miles. In addition, when the empty bottles are returned for a 30-cent deposit, the six-pack purchase will have cost 18 cents less than for throw-aways.

1. If each family in the class purchased one or two six-packs of returnable bottles each week for one year, how much energy in gasoline will be saved?
2. Using the figure from No. 1, how many miles of automobile travel are possible with the energy which is saved?
3. How much money is saved?
4. Why do you think so many people still buy beverages in throwaway containers?
5. What do you think the government or people should do about this matter? What will you do?

* *From Iowa Energy Policy Council's* **Energy Conservation Activity Packet**, Grade 6.

Quiz for Lesson Five

1. Which of these can't be recycled?
   a) manure
   b) steam
   c) bottles
   d) a lightbulb

2. A container that can be recycled usually is made from
   a) a fossil fuel
   b) a gem or stone
   c) a renewable resource

3. Which of these is not a main problem of waste?
   a) pollution
   b) loss of resources
   c) crime
   d) finding land where it can be buried or dumped.

LESSON SIX: RENEWABLE RESOURCES

Objectives:

Students should be able to identify several renewable resources and energy forms and be able to explain in a basic manner how these energies are harnessed for use.

Vocabulary:

solar power
geothermal springs
hydro power
wind generation
sundial
gnomon
solar collector
energy chain
active solar system
passive solar system
turbine
greenhouse effect

Discussion of Concept:

1. **The Sun—Life and Energy Giver**: Use resource material to explain the role the sun plays in every energy source. Ask the students to explain the role the sun played in the formation of coal, the movement of air, tides, in growing things, etc. Discuss the historical perspective of solar use.

2. **Harnessing Renewable Energy**: Discuss the different ways of harnessing renewable energies for use (solar, wind, geothermal, biomass, water). Have students explain the mechanism of different devices and how the processes work.

3. **The Role of Renewable Energy**: Discuss the amount of renewable energy now in use in the U.S. and in the world. What will its role be in the future? What are the problems in application? What choices might the students have at the turn of the century when they are in their 30's?

Materials Needed:

Drawing paper and appropriate art supplies for sun drawings or sun cut-outs; beans or chips for Energy Chain Gang

Class Activity:

1. **Sun Drawings**: Discuss symbolism and inspiration found in the sun through history; read the myth, How the Sun Made a Promise and Kept It, to students, or choose another myth to read about the sun. Have the students portray in a drawing, watercolor, poster or dramatization, the sun's role in the myth read.

2. **Sun Cut-Outs**: Make sun cut-outs from construction paper with colored cellophane inserts to hang in the classroom window.

3. **Energy Chain Gang**: Play the Energy Chain Gang (description in the resource material).

4. **The Greenhouse Effect**: Turn a glass bowl upside down on a surface in a sunny place and have children feel the heat inside (to demonstrate the greenhouse effect).

Home Activity:

1. **Research On Renewable Energy**: Have the students research one renewable energy source. It could have been used in an earlier period or be in use today. If it is an historical method have them describe how it worked and who used it. Have them visit a site where renewable energy is being used and report on the process.

2. **The Sun Dial**: Have the students report on how their sun dials work.

Preparation for Next Lesson:

Ask for volunteer student leaders for making the solar models; gather materials for models (it would be a good idea to work with each student leader to have each model painted and ready for assembly).

Solar Energy Through History

The earliest recorded accounts of homes being heated by the sun come from Greece in fifth century B.C. The Greeks designed their buildings to utilize the sun's warmth and light. The "square" in Greek architecture was constructed with an open south wall to capture solar heat. The Romans later followed this example, using solar to heat greenhouses, baths and houses. The American Indians also used the sun's energy. The Southwest tribes built homes with adobe walls to absorb and store the sun's heat. Acoma Pueblo buildings were tiered for maximum exposure and natural ventilation. Bonito Pueblo homes had high walls to control the amount of time their buildings and grounds were exposed to direct sunlight. This use of the sun is considered passive or direct solar because the sun's heat is absorbed and stored for later heating without any equipment. Many other methods of using solar energy have evolved with time.

In 212 B.C., Archimedes turned the sun's energy into a weapon. He commanded ships of an attacking Roman fleet. Reportedly the sails were black and easily caught fire, burning the vessels to the waterline. In Constantinople, in 600 A.D., a mirror-focusing system designed by Porclus ignited a fleet of ships belonging to Vitellius.

The French have been pioneers in the development of solar. The first solar-powered machine, a water pump, was built in 1615 by Solomon de Caux. Increasing pressure of expanding air heated by the sun powered the pump. In the 1700's Antoine Lavosier built a 51-inch lens to concentrate solar heat to melt metals. This was the earliest solar furnace, reaching temperatures as high as 3,190° F. And in 1880, French scientist Abel Pifre built a solar engine which powered a printing press for a publication appropriately titled, *Le Journal Soleil.*

Another Frenchman, the 18th century naturalist Horace de Saussure, demonstrated how effectively solar heat could be trapped beneath glass (known as the greenhouse effect). Yet it was Clarence M. Kemp of Baltimore, Maryland who patented the first commercial solar water heater in 1891. His heater was simply a cluster of water tanks inside a glass-covered box.

In the 1870's, Swedish inventor John Ericsson (designer of the iron ship, Monitor) designed and built the first solar-powered steam engine. However, the cost of running the engine could not compete with the cost of coal at the time. Around the same time, August Mouchot also built a solar-powered steam engine. Used to drive a water pump, the system also produced ice using an ammonia/water absorption process.

In 1901, A.G. Eneas built a solar reflector made up of 1,788 focusing mirrors which powered a steam engine. The engine pumped irrigation water on Eneas' ostrich farm in Pasadena, California. With a capacity of four horsepower, the engine pumped 1,400 gallons per minute.

In 1908, Frank Sherman established the Sun Power Company whose demonstration plant of 10,000 square feet of collectors operated a steam-powered water pump. In 1913, the company supplied 13,000 square feet of parabolic trough concentrators to Meadi, Egypt to run a 100 horsepower steam engine.

In the early 1900's solar water heaters spread from California to Florida and other areas of the U.S. The demand died down when World War II struck, but a resurgence of interest around the world occurred in the 1950's.

**From Center for Renewable Resources "Solar Energy Education Packet."*

Solar Today

By the year 2000, the United States could obtain more than 25 percent of its energy from renewable sources: sunlight, wind, hydropower, and biomass. Reaching this goal would require an ambitious national effort. But this level of solar development need cost no more – and could cost less – than would a program to obtain the same amount of energy using nuclear power or synthetic coal-based fuels.

The arguments in favor of a program to accelerate solar development are well known. Renewable energy resources, used wisely, have fewer negative envrionmental consequences than do conventional energy resources. They produce no radioactive wastes or bomb-grade materials; nor do they threaten to trigger a planetary greenhouse effect. Solar sources tend to be labor-intensive, stable and resilient; they tend to foster self-reliance, political and cultural pluralism, and a favorable balance-of-payments. Moreover, used worldwide, renewable resources should discourage the proliferation of nuclear power with its associated weapons potential.

Americans are beginning to appreciate the social, environmental, and economic advantages of solar energy. In an era when most new energy sources are deeply embattled with a hostile public, recent polls report that 94 percent of the American people favor the rapid development of solar sources. Viewed from the vantage of our great-grandchildren a hundred years hence, the arguments on behalf of solar energy make the business-as-usual approach that currently dictates our energy policy seem short-sighted and narrow in comparison.

Question No. 1: Why has solar energy become so popular?

First of all, using solar energy isn't that new. From the late 1800's until the 1940's a solar hot water boom spread from California to Florida. The popularity of these solar hot water systems declined when electricity proved less expensive. Now, however, the situation is reversing itself. Our society is using up its oil and natural gas at a furious pace. Although the U.S. has plenty of coal, deep mining is very dangerous, strip mining disrupts the environment, and burning coal pollutes the air. Another energy option – nuclear power – is complex and dangerous; plus each plant now costs more than $1 billion to build. Fortunately, the solar options are more attractive. Sunlight is abundant, dependable, and free. Moreover, the widespread use of solar systems could create safe jobs and fits well into a political system that emphasizes decentralization and local control.

Question No. 2: What are the most common ways of harnessing solar energy?

Hot water heaters: A solar collector is, in essence, a box with a black bottom and a glass top which captures the sun's warmth. When water or air is pumped through the hot collector, its temperature rises. The hot water is then piped to a very well-insulated storage tank until it is needed. About 35,000 American homes now heat their water with sunlight. In Israel, 200,000 homes have solar water heaters, and in Japan, the figure is over 2 million.

Direct passive sytems: Direct sunlight can also heat buildings. Passive systems shield a building from unwanted summer heat while capturing and retaining the sun's warmth during the colder months. South-facing windows and extra-thick masonry walls are common features of passive solar architecture – beyond a doubt the most efficient and cost-effective way to heat and cool new buildings.

Active solar systems: Active solar heating systems are more expensive, but they can be bolted onto the roofs or southern walls of existing buildings as a substitute for – or supplement to – conventional furnaces. In active systems fans or pumps move solar-heated air or liquid from collectors to storage areas, from which heat is withdrawn as needed. Solar self-sufficiency will require, in most cases, a combination of active and passive features in all but the southern rim of the United States.

Question No. 3: Are solar heating systems economical?

When space heating and hot water systems are compared on a life-cycle basis (the cost over the life of the system) many solar systems are found to be widely competitive, especially when compared with electric heat. The initial investment for a solar system is higher than for a conventional system; however, the lower initial cost of the conventional system must be supplemented by high monthly fuel bills, while there are no solar fuel costs. Five years ago, solar energy could not compete economically with low-priced fuels. Most solar homes used materials that were handcrafted in small workshops. But since 1973, the cost of solar equipment has dropped steadily while the costs of all competing energy sources have skyrocketed. Also, in most cases, the return in saved fuel costs on an investment in solar equipment is higher than an interest-earning savings account. A 1976 study by MITRE Corporation concluded that by 1980, through cost reductions for solar sytems and rising fuel costs for the other alternatives, solar systems would be economically competitive with all residential fuel types.

A solar water heater unit costs between $420 (for do-it-yourself systems) to $2400 or more (for top-of-the-line equipment professionally installed). The unit could save approximately $200 a year in oil bills. That amounts to an 8 percent return on a $2,400 investment, equal to the yield of a good industrial bond.

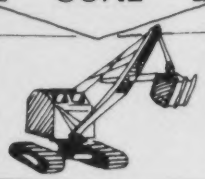
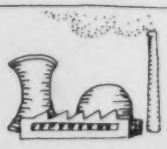
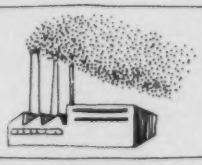
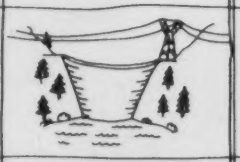
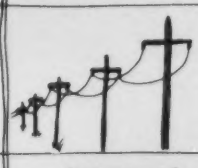
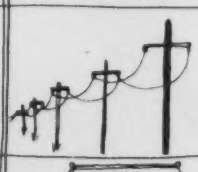
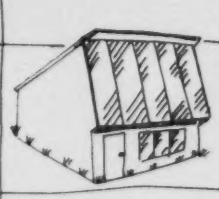
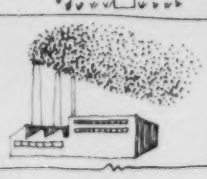
But remember, that 8 percent yield is not just income. It's saving after-tax income that would otherwise have been spent on fuel. The picture looks even brighter if you realistically assume that oil prices will rise 2 percent faster than inflation and if you can obtain a loan that spreads the cost of the initial solar investment over a twenty year period.

Question No. 4: Are solar heating systems feasible in all areas of the country?

Passive solar heated homes have been built in all regions of the country. In cloudy areas solar collectors and storage units need to be larger; the initial cost, therefore, is higher. However, a recent study shows that solar reaches economic viability earlier in the colder Northern states than in the South. This is because heating requirements are greater and conventional energy sources are more expensive in the North. Solar heating systems, therefore, usually pay for themselves faster in the North because of greater savings in fuel costs.

**From the Center for Renewable Resources' "Sun Day Fact Sheet" and updated "Solar Energy: An Introduction."*

ENERGY
STEPS TO A WARM HOME

	NUCLEAR	COAL	HYDRO	SOLAR
MINING				
LAND RECLAMATION				
TRANS-PORTATION				
ENRICHING				
TRANS-PORTATION				
GENERATING				
TRANSMISSION				
WARM HOME				
WASTE & POLLUTION				

The Energy Chain Gang

The class can dramatize the chain of energy demands in moving energy from its source to the consumer in this simple but effective game. Students will see the importance of finding the most effective means of converting "raw" energy to usable energy. They will see how energy is lost in every step of the process of energy generation by following energy from the sun to the electric lightbulb. It will become clear that the more direct the conversion the less energy is expanded (or wasted) in the process.

Beans or beads can be used to represent energy demand. Students will represent different processes, such as coal formation, coal mining, the burning of coal for steam, the turbine that uses steam to produce electricity, the networks that carry the electricity to individual homes, schools, businesses. Several processes can be explored: steam generation, nuclear, hydroelectric power, wind, solar.

First, look at the energy demands in producing electricity through coal steam generation. (Hand out copies of "The Story of Electricity" or draw a similar diagram on the board.) One student will represent the sun, whose heat and light helped to form coal and other fossil fuels over thousands of years. Two handfuls of beans will represent the sun. Have the student representing the sun drop off a handful of beans to the student representing coal. Coal is mined (coal drops off five beans to the student representing mining) and burned to create steam (mining drops off five beans to steam). The steam turns a turbine to generate electricity (five beans are dropped off to the turbine) and finally the electricity is transmitted through wires to where it is used (five more beans dropped off to networking). How many beans are left? That is the energy we use every day.

Have the students go through the chain with hydroelectric power. Begin with the sun again. The sun circulates water through precipitation and evaporation. A dam is built; water runs through a turbine; electricity is generated. Have them count the number of "energy robbers" with several processes. What about solar or wind or geothermal energy? How many robbers with them?

The Sun: Source of Inspiration

The dual nature of the sun – its magnificent gift-of-life and its power to destroy – filled primitive man with both reverence and fear. Since the beginning of recorded history, the sun has been a source of awe for all people. It has inspired poetry and art, and for centuries was one of the most widely worshipped gods in mythology and religion.

In ancient Egypt, a falcon was the symbol of the sky. Basically, Egyptians took the symbol literally and believed the sun to be the right eye of the sky-falcon and the moon, the left eye. The falcon opened only one eye at a time, thus creating day and night. The Egyptians also believed that the sun ruled the earth. Revered as a powerful god, it was worshipped under several different names, according to its position in the sky and its particular role at the time of worship.

Thousands of years later in ancient Peru, the Incas worshipped the sun calling it "Inti." A golden disk and rays of gold represented the sun's face. They thought that Inti plunged into the sea at sunset and swam under the earth all night long. Inti returned the next morning, refreshed from the long bath and ready for the day's journey acorss the sky. The Aztecs of ancient Mexico also believed that the sun was a powerful god. They built their calendar around it; and believing that the sun demanded blood, they made countless sacrifices in its honor.

The sixteenth and seventeenth century engravers in northern Europe pictured the sun as a benevolent face. As a central disk with radiating flames, the sun became a conventional symbol known to everyone because it was used so often.

A few primitive tribal societies in New Zealand and Africa still worship the sun as a god. In some towns in the more remote areas of Europe, men follow a centuries-old custom and raise their hats to pay homage to the rising sun. And in Japan, some people continue to welcome the sun each morning by clapping their hands.

Research other myths and legends about the sun. Use the background information to illustrate the sun as you see it, or as people in other cultures at other times saw it. Mythical and historical touches can be added to your sun art project. Make an Aztec calendar or decorate a simple sun dial with ancient symbols and designs.

**Adapted from Sandy Creek Nature Center's "Teacher's Guide for Sun Day," Athens, GA.*

THE SUN

SOURCE OF SYMBOLISM AND INSPIRATION

The sun has been an inspiration to people. Egyptians believed the sky was a falcon. One eye was the sun; the other was the moon.

The Inca Indians of ancient Peru worshipped the sun. When the sun went down at night it swam under the earth until morning when it rose again.

The Aztec Indians of ancient Mexico also believed the sun was a powerful god. They built their calendar around it.

Artists in northern Europe in the 15th and 16th centuries pictured the sun as a happy, caring face.

In Japan, some people welcome the sun each morning by clapping their hands.

And in some towns in Europe, men still follow an age-old custom. They tip their hats to the rising sun.

How the Sun Made a Promise and Kept It

Long, long ago, the god Weese-ke-jak made the earth and the sky. There were oceans and lakes. There was dry land. Weese-ke-jak made birds to fly in the sky. He made fish to swim in the oceans and lakes. He made animals to lie on the land. The earth was a beautiful place. But sometimes it was not a good place to live. In those days, the sun went wherever he wanted to go. He only visited the earth sometimes. When he was away it was dark and cold.

"I must do something," thought Weese-ke-jak. "We need the sun to light and warm us." Weese-ke-jak thought and thought. At last he had a plan.

"The next time the sun visits the earth," Weese-ke-jak said, "I will catch him in a net. I will keep him close to the earth. Then the earth will always be warm and light."

Weese-ke-jak made a net out of ropes. The net was very large and strong. Then Weese-ke-jak waited. When the sun came near the earth again, Weese-ke-jak took his net. He swung it around and around. Then he threw it up into the sky. The net dropped over the sun. The sun was caught. The sun pushed and pulled. But he could not free himself.

"Let me go, Weese-ke-jak," begged the sun. "Let me go! Why do you keep me in this net?"

"I have trapped you so that I can keep you near the earth," answered Weese-ke-jak. "Now the earth will be warm and light all the time."

And Weese-ke-jak would not let the sun go.

But Weese-ke-jak had made a great mistake! He had pulled the sun too near the earth.

It began to get hotter and hotter. Soon it was so hot that the birds flew down out of the sky to see what had happened. The animals came out of the forests.

"If it gets any hotter," thought Weese-ke-jak, "Everything will begin to burn. I must let the sun out of the net. Maybe I can make him a promise not to go too far away."

Then Weese-ke-jak called to the sun.

"I feel sorry for you and I might let you go. But you must promise something."

"I will promise anything you say, Weese-ke-jak," answered the sun. "Just let me go."

"Well...said Weese-ke-jak. He pretended to think about it. "Will you keep your promise?"

He pretended that he still wasn't sure he should let the sun go.

"I will keep my promise," cried the sun. "What must I do?"

"You must never go too far away," said Weese-ke-jak. "You may come close to the edges of the earth, but only in the morning and in the evening. During the day you must come just near enough to warm the earth."

"I will do as you say," said the sun. "Now please let me go!"

Weese-ke-jak went over to free the sun. But it was so hot that he could not get near the net.

So Weese-ke-jak called to the animals. "I cannot get close to the sun," he said. "Can anyone help me?"

A few of the animals were brave. They tried to help Weese-ke-jak.

First Deer tried to free the sun. Then Fox tried. They could not come near enough. It was too hot.

Then Beaver came. "I will try," he said.

In those days, Beaver did not look like he does now. He had only a few small teeth. His fur was rough and prickly. He was not very handsome. But he was brave.

Beaver ran to the net. He quickly began to bite the ropes that held the net. It was very, very hot. But Beaver did not give up. At last, Beaver bit through the last rope. The sun was free. It rose up from the earth like a balloon.

The earth became cooler.

Weese-ke-jak and the animals were happy. They ran to thank Beaver. Poor Beaver! He was not happy. The heat from the sun had ruined his coat. He had almost no fur left.

"Don't be unhappy, Beaver," said Weese-ke-jak, "Because you were so brave, I will give you two gifts."

Weese-ke-jak gave Beaver a new coat. The coat was smooth and soft. He gave Beaver a new set of fine sharp teeth.

But Weese-ke-jak did not put any fur on Beaver's tail.

"Beaver's tail will always be bare," said Weese-ke-jak, "So everyone will know how brave he was. They will remember that he set the sun free."

As for the sun, although he was free from the earth, he was not free from Weese-ke-jak's net. It still hangs over him.

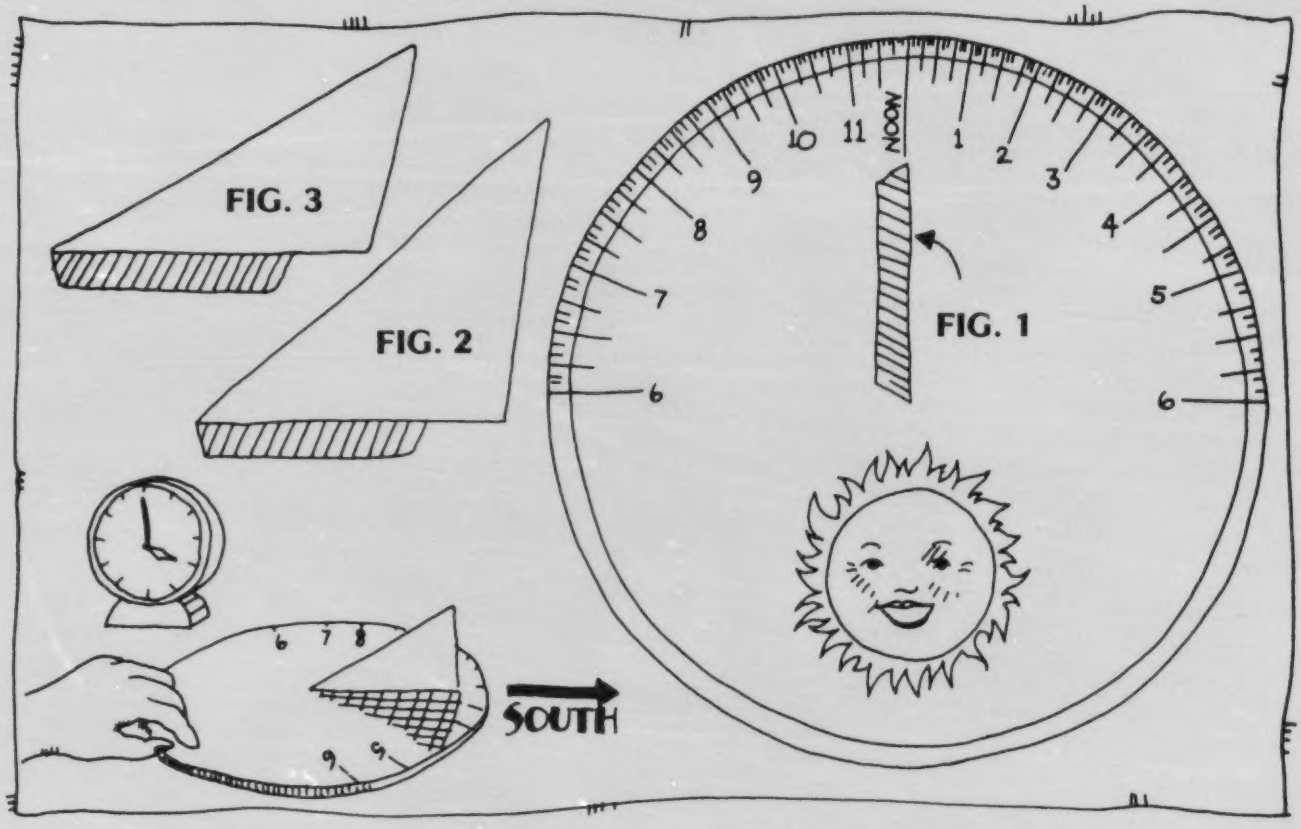
Look carefully at the sun in the morning or in the evening when it is close to the earth. Look and you will see the long ropes hanging from the sun. The ropes remind the sun of his promise to Weese-ke-jak.

And in all the days of the world since then, the sun has kept this promise.

**A Canadian Indian Myth retold by Margery Bernstein and Janet Kobrin.*

HOW TO MAKE A SUN DIAL

If you live in the North cut out figures 1 and 2; if you live in the South cut out figures 1 and 3. Use rubber cement to glue the paper figures to a piece of cardboard; cut along the lines through the paper and the cardboard. Use a sharp knife or other tool to cut through the cardboard circle where shown. Insert the base of the triangle (gnomon) through the circle (dial) so it stands at a right angle with the gnomon aligned directly along the noon axis. Bend and glue the gnomon to the back of the dial.



Be sure the dial is kept directly aligned along the noon axis. Otherwise the shadow cast by the gnomon will be off. To determine true North point the sun dial in a northerly direction; look at the time and position the dial so the correct hour shows on the dial. **Remember**: The sun knows no daylight savings time. If you are using an adjusted time frame, base your time of day on standard time and set the dial to North accordingly. Pick a place for the dial that you know will receive sun throughout the day. Be sure your dial is secure and won't be moved by wind, weather or living things. Check the dial at different times of the day to see if it is keeping good time.

There are a few factors that could throw your sun dial off slightly. We all live in time zones; your location in the zone could effect in a small way the time the sun dial gives you. Also, the angle of your gnomon may not be precisely correct for your latitude. The gnomon cut-outs are angles that reflect the number of degrees of latitude for average U.S. North and South locations. (North: 45 degress; South: 30 degrees). If your latitude varies far from either of these angles you might want to measure another angle that precisely reflects your latitude and cut the gnomon to that size.

Quiz for Lesson Six

1. Which of the following energy forms is not powered first by the sun?
   a) the wind
   b) hydro power
   c) coal
   d) none of the above

2. Why do we call some resources renewable?
   a) they can be recharged with a battery
   b) they are part of the earth's natural processes and can be used over and over
   c) they have been discovered in the last few years.

3. The energy form used most often in ancient history was
   a) hot springs
   b) the sun
   d) natural gas

LESSON SEVEN: MAKING SOLAR MODELS

Objectives:

Students should be able to explain the basic principles underlying the use of solar energy.

Vocabulary:

heat absorption
heat reflection
focal point
air circulation

Discussion of Concept:

1. **Sun Dials**: Discuss the students' experiences with charting the sun's course. What did they learn? Do they have any new thoughts about the sun? A good transition to the construction of the models might be a discussion of basic principles, such as gravity, the circulation of warm and cool air, the properties of heat absorption and reflection.

2. **How the Sun Works**: Give the class a brief description of the way each of the solar models you plan to build utilizes the sun's energy (refer to resource material).

Materials Needed:

1. **Solar water heater**: rubber band, large tin can, aluminum foil, steel wool, cardboard box, metal primer, flat black paint, glue, rubber cement, scissors, brush for painting, clear vinyl or Saran Wrap, silver duct tape.

2. **Solar cooker**: two cardboard boxes, aluminum foil, coat hanger, thumbtacks, string, pencil, two small nuts and bolts and four washers, rubber cement or Elmer's glue, ruler.

3. **Solar dryer**: cardboard box, ruler, large nail, matt knife, nylon screen, black paint or construction paper, pliers, thin wire, thick wire (such as coathanger), silver duct tape.

4. **Solar air heater**: thin string, cardboard, thin plastic bag, silver duct tape, matt knife, thumbtacks, flat black enamel or latex paint, shellac, brush.

Class Activity:

1. **Making the models**: Divide the class into groups according to the number of models you plan to build. Let the student leaders play a key role in the constructing of the models.

Home Activity:

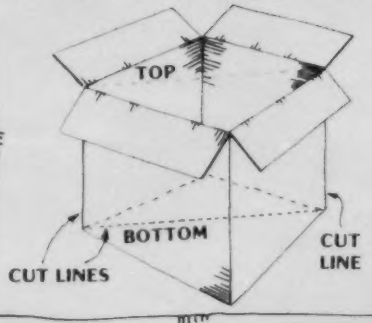
Listing ingredients: Have the students bring labels from two or three used food packages for discussion in class.

Preparation for Next Lesson:

Gather ingredients for nutritious snacks; have students bring jars and cheesecloth for growing sprouts; bring sprouts to seed.

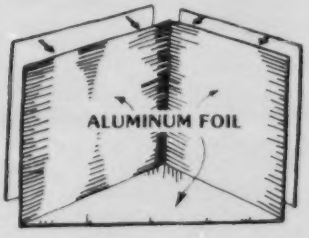
HOW TO MAKE A SOLAR WATER HEATER

1 Cut a Cardboard Box in Half Diagonally:



Cut the box in half along the diagonal as shown, leaving a triangular shaped top & bottom. Then cut of the top triangle.

The left-over piece has two sides that can be cut out to fit flat onto the sides of the remaining half-box. Glue alumninum foil to these two pieces with Rubber cement (be sure to read the directions on the label), then tape them to the sides of the half-box. These side pieces will add some thickness to the walls & help keep heat inside.



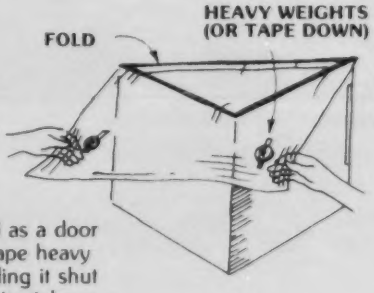
Cover the bottom with alumninum foil in the same manner.

2 Glazing the Box:

Tape a small stick of wood with silver duct tape across the top corners of the heater box as a brace.

Use Saran Wrap or clear vinyl & tape it to the bottom & sides of the box as shown. Make sure it is cut long enough to have some left over to fold over the top.

The fold-over flap can be used as a door to get into the box. You can tape heavy weights to the corners for holding it shut or just use tape for as long as it sticks.

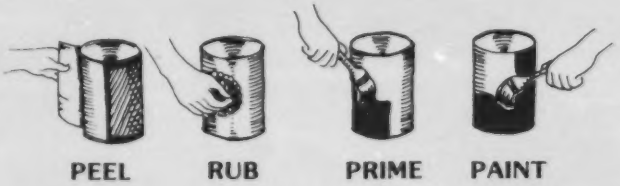


3 The Water Can

Use any can, about 1 quart size & without leaks.

Peel off any labels & rub the can with steel wool or fine sandpaper to dull the shiny finish.

Brush the can with a metal primer, let it dry completely, then paint it with a flat black enamel or latex paint.



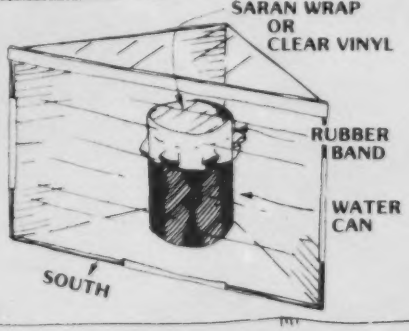
4 Set Up the Water Heater

Open the top of the heater box.

Fill the water can, cover the top of it with Saran Wrap or clear vinyl, & wrap a rubber band around the top of the can to seal it.

Place the filled can on the bottom of the heater box & close the top flap. Be sure it is well-sealed.

Face the front of the box to the south & wait for it to heat up. You can test the temperature of the water by sticking a thermometer into it. You can also experiment with different colors or different kinds of water cans and jars.

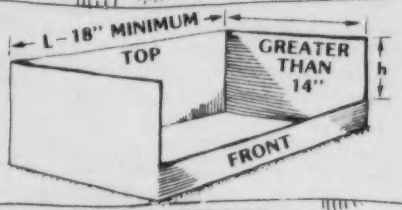


HOW TO MAKE A SOLAR COOKER

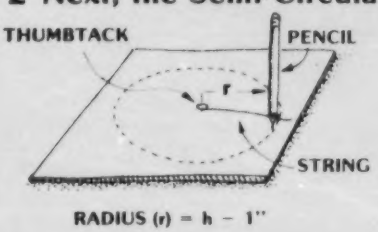
1 Begin with the Frame

You'll need a cardboard box that is strong and in good condition. A long, rectangular box will work better than a short, square one.

Cut the top and front out of the box as shown. The size of this box will determine the size of your cooker.

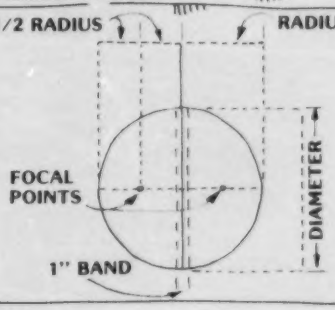


2 Next, the Semi-Circular Ends

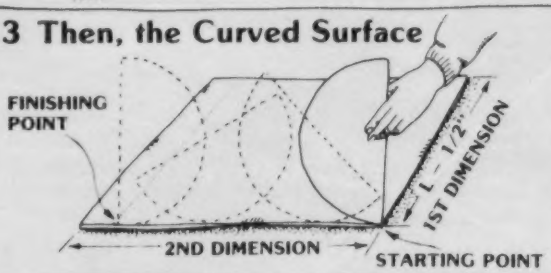


Cut a circle out of cardboard with a radius that is 1" less than the height of the front opening (h) of the frame box.

Locate the focal points as shown and cut out a 1" band, centered along the diameter.



3 Then, the Curved Surface



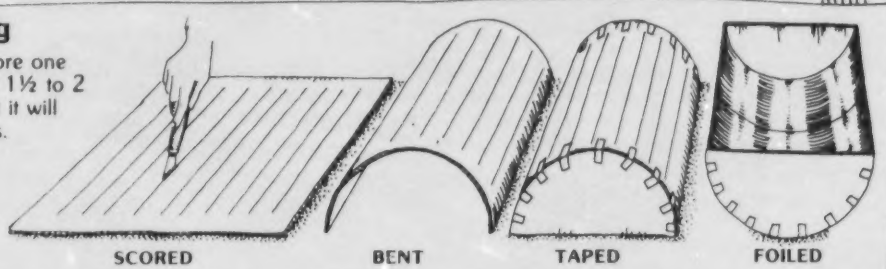
You'll need another piece of cardboard for this part.

The first dimension you need is about 1/2" shorter than the length of the frame (L).

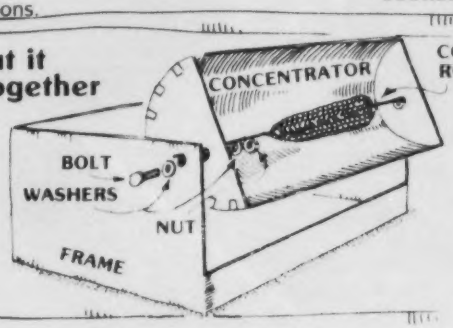
The second dimension is a little more difficult. Start the point of the semi-circular end piece as shown and roll the curved edge along the other unmeasured edge of the cardboard. Be careful not to slip or scoot it. Mark where the other point ends (and maybe add about 1/2"). This distance is your second dimension.

4 Scoring and Taping

After cutting this piece to size, score one side (but don't cut through) every 1½ to 2 inches with lines as shown so that it will bend easily around the end pieces. Tape the end pieces to the curved piece and cover the inside with aluminum foil. Rubber cement works well for htis, just be sure to read directions.



5 Put it Together



COOKING ROD

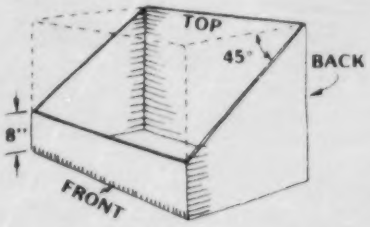
Take an unpainted thick wire and hold over a flame to burn off any excess oily substance, then push wire through the focal points of the curved concentrator to make the cooking rod.

Connect the concentrator to the frame with bolts, nuts and washers as shown.

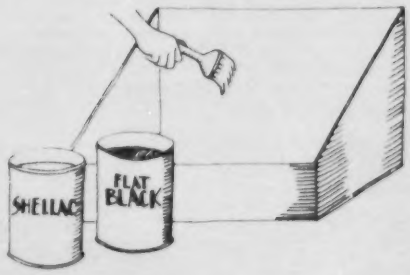
HOW TO MAKE A SOLAR FRUIT DRYER

1 FIND THE RIGHT BOX

Find a box with dimensions that will leave about 8" in front when a 45 degree angle is made from the top corner.



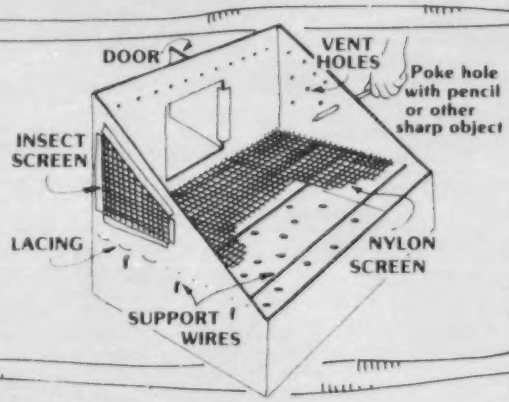
Cut a section out of the box as shown.
The entire inside of the box needs to be black. You can either glue black construction paper to the inside with "Elmers" glue, or you can paint it.
If you choose to paint, first brush on a coat of shellac, let dry for 5-7 hours, then paint with a flat black enamel or latex paint.



2 PREPARE THE BOX

Next, cut a door in the back of the box large enough to let your hand through, plus whatever you will be putting in to dry. Reinforce the uncut, hinging part of the door with a piece of duct tape.

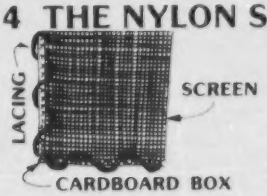
Poke holes in the bottom and sides as shown with a sharp pencil. (about 30 holes).



3

Make 3 or 4 screen support wires out of a thick wire such as a coat hanger wire, and stick them through the box near the bottom as shown and bend down the ends.

4 THE NYLON SCREEN



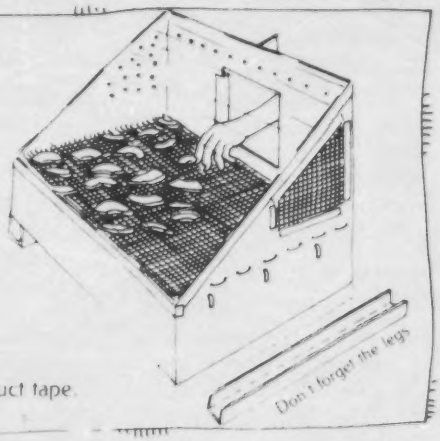
Get some nylon flyscreen material and cut it larger than the bottom of the box, so that the edges can be turned up and laced to the sides of the box.

5 GLAZING THE DRYER BOX

Use "Saran Wrap" or clear vinyl to cover the open top of the box.

Fasten the edges down with silver duct tape.

Make 2 legs out of cardboard and fasten them to the bottom with duct tape as shown.



INSECTS?

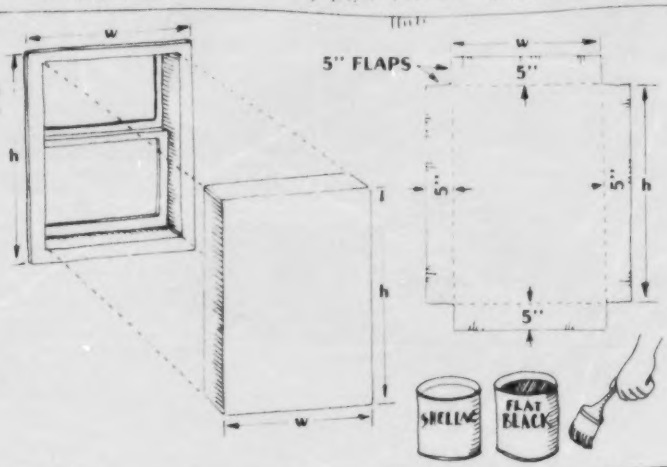
If so, cover the vent holes with more of the nylon screen and fasten it with duct tape.

HOW TO MAKE A SOLAR AIR HEATER

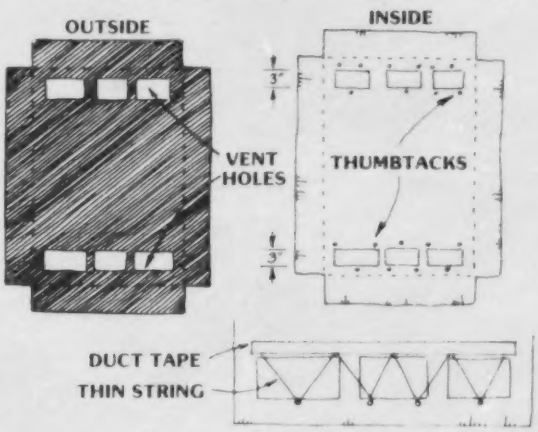
1 MEASURE A SOUTH-FACING WINDOW TO BE USED AND FIND A LARGE ENOUGH PIECE OF CARDBOARD

Cut the cardboard to fit snugly inside the window frame.

Brush one side with shellac, then after drying for 5-7 hours, paint it with flat black enamel or latex paint.



2 THEN MAKE THE VENT HOLES



Cut them near the top and bottom at least 3" high.

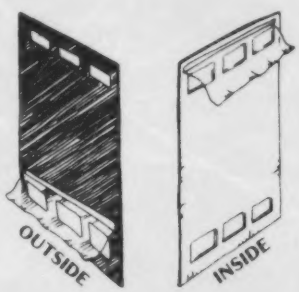
Push thumbtacks into the cardboard around the vent holes as shown.

Weave some thin string around the thumbtacks and across the vent holes.

Cover up the thumbtacks with silver duct tape to keep them from falling out.

Get some thin plastic film (like food wrap — but not wax paper) and cut it large enough to cover the vent holes.

Tape the plastic to the outside (black side) of the bottom vents and to the inside (string side) and top vents as shown.



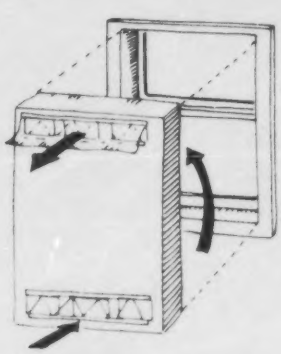
3 NOW YOU CAN INSTALL THE HEATER

Place the cardboard, black side facing the window, top vents up, (so that the plastic flaps hang down over the vent holes), then tape it to the window frame with masking tape.

Leave an air space between the glass and the cardboard, but none around the edges of the cardboard.

Don't leave the masking tape on the window frame too many days, or it may pull the paint off with it.

A smaller model can be made using a cardboard box taped to the window, leaving an airspace between the glass and the back of the box. Just follow the above directions.



How the Solar Models Work

Solar Water Heater:

A metal container for water is painted black and placed in the focal point of a triangular reflective box. The open side of the box is covered with clear plastic. The sun shines through the plastic and is absorbed by the black can, heating the water. The silver sides of the box reflect the sun's rays to the container in the center of the box, further contributing to the heating of the water.

Solar Cooker:

A rotisserie-like half cylinder, lined with aluminum, is angled toward the sun. The cylinder reflects solar heat to the center, where a wire is mounted like a spit on a rotisserie.

Solar Dryer:

A box painted black absorbs the sun's heat. An opening in the box is slanted for better exposure to the sun. Plastic is placed over the opening to keep the heat in. Holes are cut in the bottom and top of the box to draw cool air in and circulate the hot air out. The cool air is drawn in at the base and the hot air moves out the top, carrying with it the moisture released from the drying foods. The screens suspend the food so air can easily circulate and the drying process is accomplished rapidly. Legs under the box allow air to circulate underneath.

Solar Air Heater:

Air is heated and circulated through this cardboard model of a window heater. A cardboard box (about 3 inches in depth) is painted black on the inside surface and taped to the inside of a sunny window (south-facing is best). If no window is available it is covered with saran wrap or vinyl or polyethylene to simulate the glass surface of the window. The black surface of the box faces outside, absorbing heat from the sun. A system of air ducts cut into the back of the box allows cool air to be drawn in from the room at the base, heated, and circulated out the top back into the room. Plastic flaps act as backdraft dampers to keep the box from cooling air, rather than heating it, when the sun goes down.

Tips for Successful Solar Models

Preparation: The model building goes much faster and is much easier if the painting is done ahead of time. The shellac can be diluted. It is used to seal the cardboard to prevent infiltration of the paint. The black paint is applied after the shellac has had a few hours to dry.

The Correct Aim: The models should be directly aimed at the sun at all times. You'll find adjustment in aim will be needed at least every half hour to be directly in line with the sun's rays. With the solar cooker you should be sure to aim the half-cylinder directly at the sun. A good way to check if you are directly aligned with the sun's rays is to check for shadows in the inside corners of the model boxes. If there is any shadow, it should be equal on both sides of the box. Another good indicator is to insert a nail, or other thin, long object, directly in the front and center of the various models (you'll have to locate an appropriate spot for each model). When your model is aimed correctly, the nail will cast its shadow straight back. Another method for aligning the solar cooker is to stand in front of the cooker and focus the glare from the reflectors on the rotisserie spit.

Keep Clean and Tight: Keep the reflector area and plastic covering of the various models clean and tightly attached. Dust will prevent full reflection and a loose plastic covering will hinder sun absorption as well as reflection.

Results

The models were made by a sixth grade class in Butte and tested in the classroom as well as at NCAT. Through trial and error we found success with each model. We'd like to share some of the results of our tests and provide the intrepid teacher with practical suggestions to make his or her course a little smoother than the course we pursued.

The Solar Cooker:

This model is popular as an elementary school project because it is simple to make and hot dogs are a popular food item with youngsters. However, since other lessons in the curriculum stress the nutritional value of food in its original form, we tried to find other foods that would cook as well, if not better, than the hot dog.

It took up to 45 minutes to cook a hot dog on an 18" solar cooker in Butte on a hot summer day (about 80°). We placed a polyethelene cover over the rotisserie and were able to cook a hot dog in about 20 to 30 minutes. The polyethelene was taped to the back of the cooker and around the sides.

We also experimented with marshmallows, pieces of vegetables, corn on the cob and a whole apple. We

found surprising success with the apple and recommend it as the most nutritious, tasty, cookable food for the cooker. Using the cover, we baked an apple in about 1 hour. Its appearance was similar to that of an apple baked in an electric oven and it tasted better! If you let it cook until it is quite soft (another 15 to 20 minutes), you can peel it and mash it for apple sauce.

Virtually anything will cook, if placed properly on the rotisserie. Use your imagination to come up with a new food idea. One thing to remember is that the darker the color of the food, the faster and more efficiently it will cook. Marshmallows reflect the sun and cook slower than hot dogs. We had thought corn would be an ideal food, but found the light yellow color a deterrent to cooking. We also skewered an unhusked ear of corn on the cooker and found the corn would cook in 45 minutes to an hour, but somehow the flavor of freshly steamed corn was lost in the slow process.

The spit of the rotisserie should be strong enough to hold without bending whatever you want to cook; if not, the spit will bend and the food to be cooked will not be in the focal center of the cooker. Make sure you keep the holes for the spit small, so it will fit tightly and hold in place when the food is rotated.

The larger the cooker, the faster the food will cook. Our model is about 18 inches. If you are able to secure larger pieces of cardboard, we heartily recommend building a larger cooker. You'll find your cooking time dropping in direct proportion to the size of your cooker. Using a plastic or polyethelene covering is recommended; it will speed up the process considerably.

The Solar Water Heater:

The water heater may be the most effective demonstration project suggested here. Make sure the plastic covering used is tight around the box and the heater is aimed directly toward the sun and you'll find sure success. Of course, a sunny, clear day is the best time for testing any of the models, but our experiments showed that the water heater will perform under relatively adverse conditions.

First, we tested on a clear, warm day (about 85°) in Butte. We began with very cold water from the tap. In less than an hour the water was face-washing warm; in two hours, it was beginning to steam and good for making tea; in three hours it was too hot to touch. On a cloudy, cooler summer day (about 70°) in Butte the water heated to face-washing temperature in four hours.

The Solar Dryer:

We found the most success with apple slices in this solar model. An apple was cored and peeled and sliced in 1/4" sections. The sections were placed on the screen in the dryer, spaced so they did not touch. In about 6 hours they had dried to tasty tidbits that could rival any product found on the store shelf. We also tried apricots. They took two days to dry (we put them out for two days for about 7 hours each day) and were good, but not as good as the apple slices. If placed in a sunny location, the solar dryer will work well inside. If you are worried about browning of the fruit, soak the sections in a salt water solution (1 teaspoon salt to 1 gallon water) and rinse well before drying. We did not soak our apples and had no trouble with browning.

Things to Remember:

Various factors will determine the degree of success you will find with the models. We tested in Butte, elevation 5500 feet, where the temperature rarely reaches above 80 degrees and the growing season is rarely longer than 70 days. However, we tested usually on clear, sunny days, some of the warmest days of the year. We would suggest you try the models on the clearest days possible. It is easiest to experiment with them outside on a warm, sunny day, but if you can find a room with good south and west exposure you can angle the models so they are exposed to the sun and your results should be similar to outside experiments. Be sure to have the models angled directly to the sun and stress the importance of the focal point being in direct alignment.

Quiz for Lesson Seven

1. Which of the following will NOT reflect the sun's rays?
   a) metal painted white
   b) aluminum foil
   c) wood painted black

2. The part of the sun dial that casts a shadow is called:
   a) a shadow hand
   b) an arrow
   c) a gnomon

3. The shadow cast by the sun dial will tell you the time when:
   a) it is cloudy
   b) the sun moves across the sky
   c) someone is standing close to it

4. The focal point in a solar collector is:
   a) the point where the sun's rays are reflected
   b) the point where the sun's rays strike the collector
   c) the top of the collector

LESSON EIGHT: THE FOOD WE EAT

Objectives:

Students should understand the steps required in taking food from its source through to the consumer and the energy required in the process.

Vocabulary:

nutrition
processed foods
food packaging
package labeling
whole grains and nuts
sprouts

Discussion of Concept:

1. **What Did You Eat Yesterday?:** Ask the students what they ate the day before. Break the meals down into basic food groups. Look at the amount of sugared items consumed, and the amount of meat, fruits, vegetables.

2. **Fresh vs. Processed:** How many of the foods eaten were fresh? How many canned or frozen? How many fast food, or processed? Take a look at the differences between one food element in its original state and the processed equivalent. A good example might be brown whole grain rice and Minute Rice. Are there differences in cost, preparation time, packaging? What about taste and nutrition? Use the Food Chain in the resource material to demonstrate the steps and energy required to move chicken, flour, shortening, spices, assorted vegetables and additives from their original form to the frozen chicken pot pie on the grocery shelf.

3. **Energy, Food, and Packaging:** Refer to resource material to discuss energy requirements in food production and packaging; compare. Contrast the packaging methods used in an American supermarket, a neighborhood grocery store, an open market in Mexico, a local farmers' market.

Materials Needed:

Labels from cans, boxes and packaging, or a bag of groceries; ingredients for nutritional snacks; jars, cheesecloth and sprouts.

Class Activity:

1. **What's in the Food We Eat?** You might want to divide the class into groups to discuss the ingredients listed on the packages they brought. Different items may demonstrate different points. Refer to the chart to show sugar content of breakfast cereals and other reference material for contents and meaning of various ingredients and terms. The students should study the labels and draw conclusions about what food they think is the most nutritious.

2. **Solar Tea:** Make solar tea by placing a clear jar filled with cold water and tea bags in a sunny place in the classroom or outside.

3. **Nutritional Snacks:** Make snacks from fruits, grains or nuts. Recipes are provided in the resource material.

Home Activity:

1. **Growing Sprouts:** Either do one sprout-growing demonstration in the class or have students grow their own at home. If you plan to have the students take the sprouts home, you can give the directions and begin the project in class. If you want to make malted milks, sprout wheat berries.

2. **Interview the Older Generation:** Have the students interview an older person about ways of growing and preserving food 40 years ago.

Preparation for Next Lesson:

Gather cream cheese and crackers to eat with sprouts; gather materials needed for the garbage pail compost; arrange for a field trip to farmers' market, food co-op or small farm (optional); arrange for a guest speaker.

Energy and the Food System

The food system starts with the sun that gives energy to plant life. Farmers and ranchers use the sun's energy and oil, gas, electricity and natural gas – other forms of the sun – to produce crops. Trucks, trains and barges transport crops and livestock to markets where the goods are sold to processors. Processors change the crops and animal products into food that we buy at stores. Processing usually includes applying heat or cold, combining ingredients and packing the products to keep them undamaged, clean and more attractive to the buyer. Retail stores order the products from the processors and receive the products via trucks, train, and sometimes, planes. Retailers also store the items until they are sold. Then, we come into the picture – we buy the product, take it home and usually do some type of processing ourselves, like heating or cooling the item.

About 17 percent of the energy we use in the U.S. each year goes into growing, processing, distributing, storing and home preparation of food. But, one fact to think about is that it takes eight times more energy to produce, process and transport food than the food energy (in calories) we get from eating the products.

In the past it took much less energy to produce food. Before 1900, all the farm work was done by animals and people. Farmers accounted for 90 percent of the population. When the internal combustion engine was invented, the farmer benefited more than any other worker. Energy prices were cheap and farmers could afford to buy more land and produce much more food than before. Today, farmers comprise only four percent of the American population. Because of advanced machinery and fertilizers, one American farmer produces enough food and fiber for more than 50 people.

Farming is only the first part of the food system, using about 18 percent of the energy used in the food system. Food processing accounts for 33 percent of energy used. Processing methods vary in energy usage. The most energy intensive method is freezing. The least energy intensive is packing and shipping a fresh item that requires no refrigeration.

Canning takes less energy than freezing because of the electricity required to keep the frozen foods cold until the consumer can prepare them. Convenience foods that have been dehydrated and combined with other ingredients require large amounts of energy to be produced.

Transportation of produce takes about 3 percent of the energy used in the food system. Transportation – a vital part of today's system – is needed to get raw materials to the processor and from the processor to the consumer. Trucks have become the main form of transportation because of a well-developed highway system in this country and the convenient delivery of trucking. But trucks require more energy per ton of freight than trains or ships.

Wholesale and retail food outlets use 16 percent of the energy used in the food system. Electricity and natural gas keep buildings warm and food cold. Consumers prefer having wide selections of products from which to choose, which require larger stores. Open freezer units often battle against heating systems and are gradually being replaced by closed units. Lighting is important for customers to clearly see product labels and prices. Lighting consumes a large amount of energy in stores.

Consumers are major users in the food system, with home preparation of food accounting for 30 percent of energy used. Electricity and natural gas are the major sources of energy for cooking and refrigeration. Hot water heaters, freezers, refrigerators and ranges require the most energy for operation. Heating appliances, such as toasters, hot plates and blow dryers, require more energy on the average than appliances that don't heat, like electric knives or mixers.

What's For Lunch The Soup or the Can?

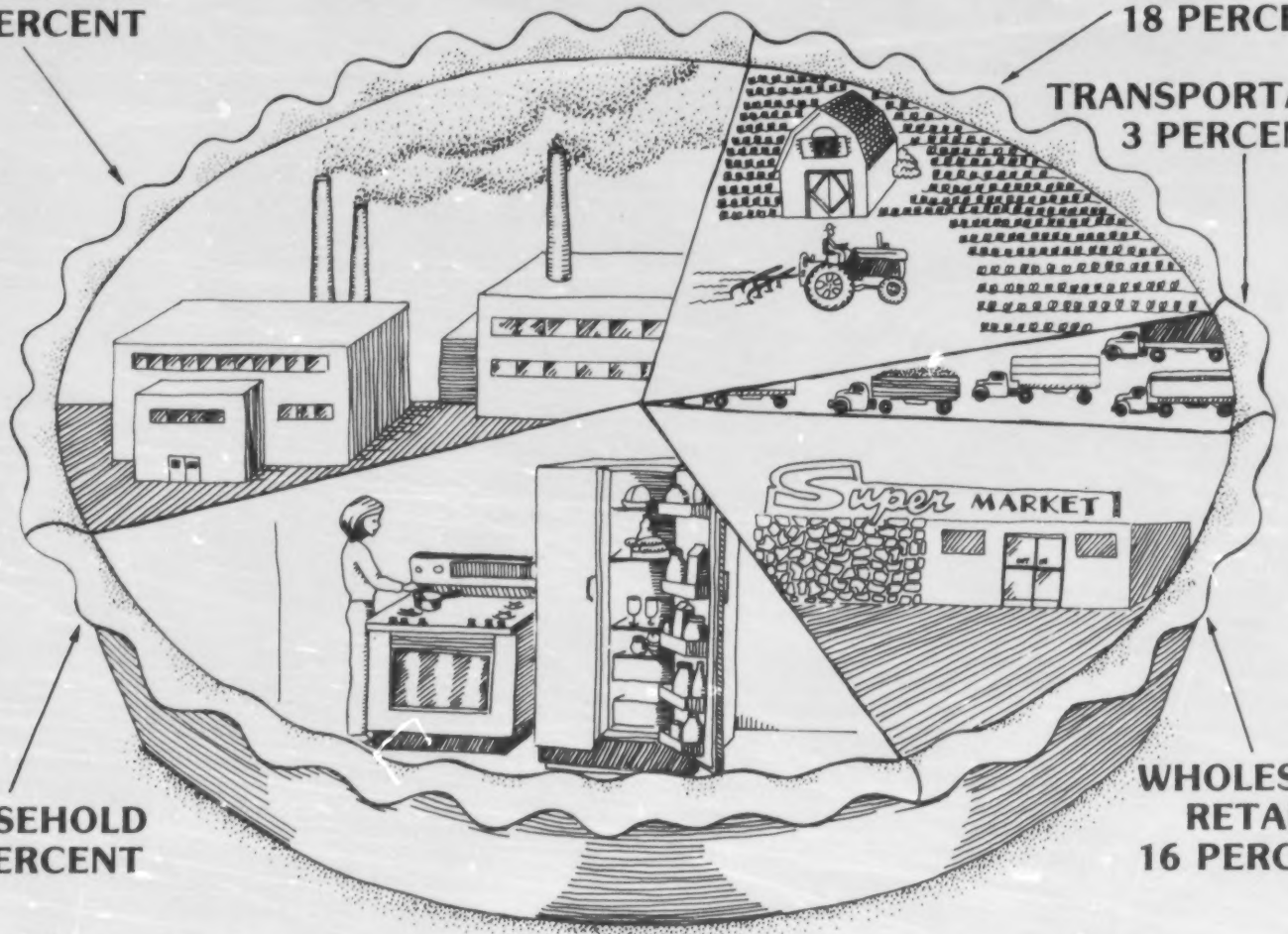
Using the information presented in the accompanying charts, have students compare the costs of different methods of packaging. Other factors are important also: Are the packages made of renewable resources? If not, could they be used again? What materials that can't be used again are biodegradable? What materials are recyclable? A returnable pop bottle and a Mason jar require the most energy in production, but they can be reused. A styrofoam cup requires little energy in production, comparatively, but it is not made of a renewable resource (production of styrofoam requires substantial amounts of petroleum-based fuels); it cannot be reused; it is not biodegradable and it can't be recycled. Students should be presented with these sorts of comparisons and asked to draw their own conclusions on what packaging method they think is best.

Another interesting comparison is the energy required in food processing and packaging and the energy obtained in calories when we eat it. Look again at the charts. You can see a returnable pop bottle requires 1.42 kWh to produce, comparable to about 1250 calories. Many people consume less than that number of calories in one day. And the pop contained in the bottle is 98 calories, less than 10 percent of the caloric energy required to make the bottle. Similar comparisons can be drawn from the rest of the material presented.

** From Montana Power Company's Food and Energy Unit, "Pie in the Sky," developed by Deborah Cunningham, 1979.*

ENERGY AND OUR FOOD SYSTEM

17 percent of the Total U.S. Energy Supply Goes to Food Production Processing, Transportation and Storage



WHAT CONTAINERS SAVE ENERGY?

Kilowatt (kw) = 1,000 watts
Kilowatt hour (Kwh) = 1,000 watts on for 1 hour
860 food calories = 1 kwh

Energy Needed to Make Container	Container	Renewable	Reusable	Biodegradable	Recyclable
1.42 kwh	returnable pop bottle		X		X
.85 kwh	non-returnable pop bottle				X
.24 kwh	milk carton	X		X	
.58 kwh	steel can			X	X
1.28 kwh	aluminum can				X
.84 kwh	paper cup	X		X	X
.25 kwh	styrofoam cup				
1.42 kwh	mason jar		X		X

IS THERE MORE ENERGY IN THE POP OR THE BOTTLE?

Energy Needed to Make Container	Container	Energy We Get in Drinking the Contents
1.42 kwh	pop bottle	.10 kwh
.24 kwh	milk carton	.19 kwh
.58 kwh	steel can (tomato juice)	.05 kwh
.84 kwh	paper cup (coffee)	.001 kwh

Understanding Labeling

Intentional Food Additives are substances purposely put into food to give it some desirable characteristic: color, flavor, texture, stability, or to retard spoilage. Some additives are nutrients which are added to foods to increase their nutritional value, such as vitamin C added to fruit drinks or potassium iodide added to salt.

Flavoring Agents such as ginger and cinnamon are additives, as well as substances which themselves do not add flavor but bring out the flavor of other ingredients, for example, monosodium glutamate (MSG).

Antioxidants are used to prevent rancidity of fats during storage and antimyotic agents are used to prevent or control spoilage oranisms such as mold, bacteria, and yeast; among the most common of the latter additives are salt and sugar.

Emulsifiers are used to keep oil dispersed in a water medium such as in salad dressing.

Stabilizers are used to keep the texture of the product smooth and stable, for instance, keeping the water in ice cream from forming ice crystals and destroying the smoothness of the ice cream.

Coloring Compounds are used to make the product more attractive to the eye. Earlier, these compounds were natural substances, such as beet juice, but today, more than 90 percent are synthetic; they are among the most controversial of the additives.

There are also many other classes of food additives designed to perform various functions in the processing and manufacture of foods and food products.

Federal law requires all food labels to show certain information. The labels must be easily read and understood and must not contain any false or misleading information.

Information required on label	Example
The product name:	Apricots
The variety, style, and packaging medium:	Apricot halves in heavy syrup
Net content or net weight: (This includes the packing medium, such as water, syrup, etc.)	Net weight 15 oz.
Name, place of business, zip code of the manufacturer, packer or distributor:	Distributed by: Thomas & Company 1234 Cannery Lane Seattle, WA 98773
A list of ingredients; in order of decreasing weight unless a standard of identity has been established for that food. If the ingredients listed are "green beans, water, sugar, salt," the amount of green beans inside weighs the most of all the ingredients. Artificial colors and flavors, and chemical preservatives must be declared on the labels of all food containing them, except butter, cheese, and ice cream. If the colors or flavors are artificial, they must be designated as such.	

Terms related to nutrition labeling

FDA – (Food and Drug Administration) The federal governmental agency that is responsible for laws to protect the consumer's food, makes sure drugs are safe and effective, develops standards for packaging and labeling, devised the U.S. RDA, approves additives for safety, and inspects plants that manufacture foods, drugs and cosmetics.

USDA – (United States Department of Agriculture) The federal agency aimed at guaranteeing a safe, adequate supply of food, grading food, providing educational information on growing and eating food, and operating the federal meat and poultry inspection service.

Imitation Food – A food which is nutritionally inferior to a food product for which it is a substitute. Example: Many products are now using soybeans to make products resemble beef or chicken. If we look at the ingredients, it will indicate soybean as the first ingredient. So, a product called "Chicken-O" must also have on the product label "Imitation Chicken."

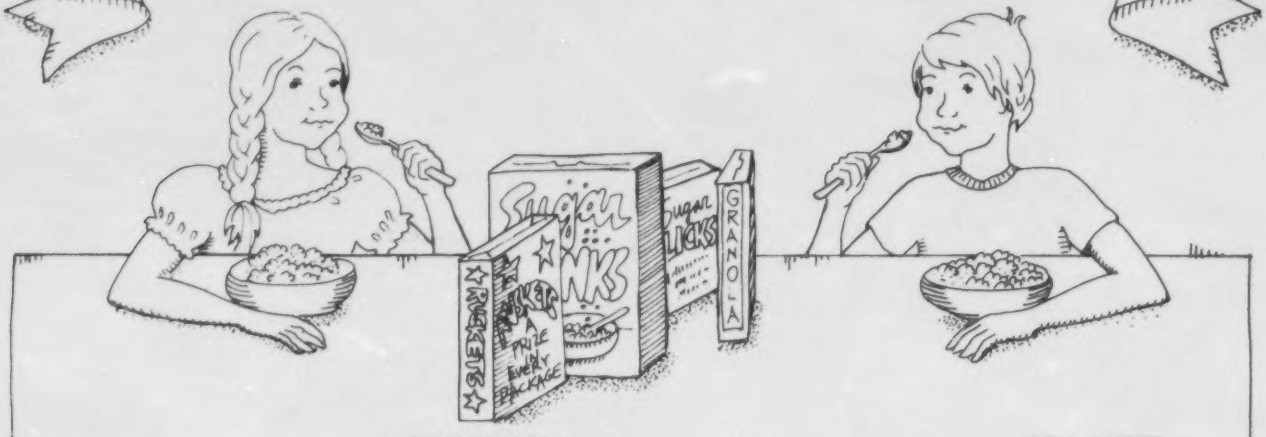
"Restored" – Food items that have had nutrients added to them to replace those nutrients that may have been decreased or destroyed during processing or storage. Nutrients are restored to the level assumed to be found naturally in the food before it was processed.

"Enriched" – Refers to foods such as breads, cereal products, grains that have lost certain nutrients in the processing. A food becomes enriched when specific nutrients, thiamin, riboflavin, niacin, and iron are added or returned to the refined food product. Addition of other nutrients lost in processing is optional.

"Fortified" – Refers to the addition of nutrients beyond a level that is normally found in the food. Example: Vitamin D added to milk.

**These materials borrowed from "Energy, Food and You" Program, Washington State Office of Environmental Education, N.W. Section.*

PERCENT OF SUCROSE IN READY-TO-EAT BREAKFAST CEREALS

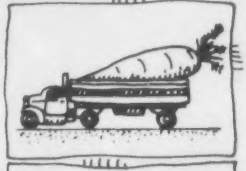
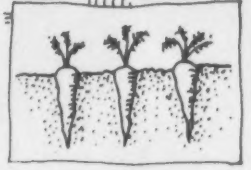


NAME	PERCENT SUCROSE
All Bran	20.0
Alpen	3.8
Alpha Bits	40.3
Apple Jacks	55.0
Baron Von Redberry	45.8
Boo Berry	45.7
Bran Buds	30.2
40 Percent Bran Flakes (Kellogg)	16.2
40 Percent Bran Flakes (Post)	15.8
100 Percent Bran	18.4
Brown Sugar-Cinnamon Frosted Mini Wheats	16.0
Buck Wheats	13.6
Cap'n Crunch	43.3
Cheerios	2.2
Cinnamon Crunch	50.3
Cocoa Krispies	45.9
Cocoa Pebbles	53.5
Cocoa Puffs	43.0
Concentrate	9.9
Corn Chex	7.5
Corn Flakes (Food Club)	7.0
Corn Flakes (Kellogg)	7.8
Corn Flakes (Kroger)	5.1
Corn Total	4.4
Count Chocula	44.2
Crisp Rice	8.8
Crispy Rice	7.3
Crunch Berries	43.4
Fortified Oat Flakes	22.2
Frankenberry	44.0
Froot Loops	47.4
Frosted Flakes	44.0
Frosted Mini Wheats	33.6
Fruity Pebbles	55.1
Granola	16.6
Granola (with almonds)	21.4
Granola (with dates)	14.5
Granola (with raisins)	14.5
Grape Nut Flakes	7.0

NAME	PERCENT SUCROSE
Grape Nuts	0.00
Heartland	23.1
Heartland (with raisins)	13.5
Honeycomb	48.8
King Vitamin	58.5
Kaboom	43.8
Life	14.5
Lucky Charms	50.4
Orange Quangaroos	44.7
Peanut Butter	5.2
Pink Panther	49.2
Post Toasties	4.1
Product 19	4.1
Puffed Rice	2.4
Puffed Wheat	3.5
Quisp	44.9
Raisin Bran (Kellogg)	10.6
Raisin Bran (Skinner)	9.6
Rice Chex	8.5
Rice Crispies (Kellogg)	10.0
Shredded Wheat (Large)	1.0
Shredded Wheat (Spoon)	1.3
Sir Grapefellow	40.7
Special K	4.4
Sugar Frosted Corn Flakes	15.6
Sugar Frosted Flakes	29.0
Sugar Pops	37.8
Sugar Smacks	61.3
Sugar Sparkled Corn Flakes	32.2
Super Sugar Chex	24.5
Super Orange Crisp	40.7
Super Sugar Crisp	40.7
Team	15.9
Total	8.1
Trix	46.6
Uncle Sam Cereal	2.4
Vanilla Crunch	45.8
Wheat Chex	2.6
Wheaties	4.7

* From a study by Dr. Ira Shannon, Veterans' Administration Hospital, Houston, Texas, Director, Oral Disease Research Laboratory

A LOOK AT FOUR FOOD CHAINS

eat it	eat it	eat it	eat it	
	cook it	cook it	thaw it, cook it, throw away the package	
		take it home	take it home and put it in the freezer	
		you drive to market and buy it	you drive to market and buy it	
		they refrigerate it at the market	market keeps it frozen	
		it's transported to market	refrigerated truck takes it to market	
			it's sliced by a machine, packaged, and frozen	
			it's transported to a processing plant	
you grow a vegetable in your garden	you grow a vegetable in your garden	someone else grows a vegetable	someone else grows a vegetable	

Growing Sprouts

In choosing seeds to sprout, buy only those which have not been chemically treated. Among the most popular seeds and grain for sprouting are alfalfa and mung beans. Avoid tomato seeds and potato sprouts because they are poisonous.

Sprouts are a relatively inexpensive food when one considers that one-half cup swells to one and one-half cups after soaking and explodes into one quart of edible sprouts, costing about one cent a serving.

Sprouting also is very nutritious. Researchers working at such institutions as Yale, the University of Pennsylvania and McGill University have demonstrated that the nutritional value of seeds increases dramatically during the first two or three days of sprouting. The vitamin C content of soybeans increases more than 500 percent by the third day. There are significant increases in many of the B vitamins and in vitamin E in many sprouted seeds, while the protein level remains generally high. Starch content is reduced as it is converted to sugar. However, no two varieties of seeds follow the same nutritional content pattern during sprouting.

Method for Growing Sprouts

Place two to three tablespoons of seeds in a quart jar. Fill the jar with lukewarm water and let it stand overnight. Cover the top of the jar with cheesecloth or nylon mesh and secure tightly. Drain off the water that has been soaking the seeds overnight. This water can be used to water other plants. Place the jar on its side, so that seeds form a thin layer around the jar. Place it in a dark place where it is warm and humid. At least twice a day rinse the sprouts by pouring lukewarm water into the jar, swirling around and pouring out the excess. Seeds should be kept moist but not wet. Depending on the variety of seeds, sprouts will develop in three to five days. They should be removed before rootlets appear, but when the first young leaves appear the jar may be placed in direct sunlight for development of green chlorophyll. Rinse and drain the sprouts daily. When they have reached the optimum length, store in covered containers in the refrigerator. They will keep for several days in the refrigerator. Use the whole sprouted seed.

Whenever possible, sprouted seeds should be used without cooking for full retention of all nutrients. Sprouts can be used in salads, on sandwiches, in soups, vegetable dishes, omelets, and breads.

Making Malt From Sprouts

When wheat berry sprout rootlets are still white, spread evenly over a baking sheet and bake at 150° until dry (or they can be dried in the sun). Grind up dry sprouts in a mill or blender until fine. Put in refrigerator to be used as malt.

Seeds	Best when
alfalfa sprouts	about one inch long
chick-peas	one-half inch to three-quarters inch long
lentil seeds	no longer than one inch
mung bean sprouts	one and one-half inches to two and one-half inches
sesame and sunflower	as soon as sprouts are visible
soybeans	one-half inch long

Nutritional Snacks

Few foods cause so much indirect harm as do the usual varieties of candies. Since most candies are made principally of refined sugar (which contains calories but no nutrients) they cannot build health. Any concentrated sweet destroys the appetite and helps cause tooth decay.

The detrimental effects of sweets upon the teeth can be partly overcome by incorporating generous amounts of calcium (powdered milk) in candy and other foods containing much sugar. Sunflower seeds, popcorn, peanuts and other whole seeds and nuts are excellent candy substitutes.

Goop and Gorp

Kids love the sound of the words Goop and Gorp and they can help make it. If you don't have all the ingredients, use what you do have and add other appropriate ingredients. Mix everything together in a mixing bowl. For Goop add just enough honey or peanut butter to roll the Goop into balls.

Banana Milkshake

Mash a ripe banana with a fork. (If an electric blender is handy you may make the shakes in it, but the ingredients also can be blended with an egg beater or by shaking them in a tightly covered jar). Pour one cup of milk on the banana. Add honey, coconut, chopped nuts, a raw egg or other nutritious ingredients. Mix well. A banana and a cup of milk should make two shakes.

Goop

- granola or uncooked oatmeal
- raisins or chopped dried fruit
- chopped nuts
- wheat germ
- shredded coconut
- honey or peanut butter

Gorp

- sunflower seeds
- pumpkin seeds
- toasted sesame seeds
- raisins or carob chips
- chopped nuts
- shredded coconut

Quiz for Lesson Eight

1. Look at the following foods and make two lists: one of foods in their original form and the other of processed foods. Sunflower seeds, Campbell's tomato soup, frozen peas, Minute rice, potato chips, milk, Jello, eggs, salad dressing.

   Take one item from each list and describe the processes used before it reached the grocery store shelf.

2. What part of our food system uses the most energy?
   a) growing the food
   b) transporting the food
   c) processing the food
   d) cooking the food

3. Divide the following list of packaging material into two groups – those made from renewable resources and those made from non-renewable resources:
   a steel can
   a milk carton
   a styrofoam cup
   Saran Wrap
   a paper sack

LESSON NINE: GROWING YOUR OWN

Objectives:

Students should be able to compare the food system of 40 years ago to today's and to list the main tenets of organic gardening.

Vocabulary:

root cellar
food preservation
decomposition
aeration
bacteria
fungi
community gardens

Discussion of Concept:

1. **Food Forty Years Ago:** Discuss the students' interviews with the older generation. How much of the food eaten was canned, dried or put in a brine? How much of the meat came from animals butchered nearby? How many people grew their own gardens? What about root cellars? When did things begin to change? What were the causes for change? Look at the Food Chain to compare the steps usually taken in food preparation now compared to 40 years ago.

2. **Locally-Grown Food:** What crops are grown locally? Is there a farmers' market in the area? What advantages are there to eating locally-grown food: nutritionally? economically? energy-wise? Discuss the energy needs for the Food Chain (refer to resource material).

3. **Organic Gardening and Composting:** Use resource material to explain organic methods, such as composting and mulching. Point out various methods of gardening, such as truck farming, growing vegetables in containers on a roof, community gardens, backyard gardens, greenhouses.

Materials Needed:

Crackers and cream cheese to eat with sprouts; solar dryer if you plan to dry malt; materials for garbage pail compost – galvanized pail, basin, two bricks, tarp, compost ingredients.

Class Activity:

1. **Garbage Pail Compost:** Make the compost. (Check with the school cafeteria for kitchen scraps; gather the other materials from local sources.) Resource material contains tips for making a compost. The compost in the pail should break down within 6-8 weeks.

2. **Malted Milk and Creamcheese Sprouts:** Dry the barley sprouts in the solar dryer, grind and make malted milks. Put the sprouts on crackers for a nutritious snack.

3. **Guest Speaker:** Invite a knowledgeable, articulate elderly person or an expert in gardening and home preparation methods to the class to talk about the old ways.

4. **Field Trip:** Take the students to a farmers' market, a small farm, or a food cooperative.

Home Activity:

1. **Growing Food at Home:** Pass out "Tips for a Successful Garden" for students who want to grow a garden at home. You also might suggest they start a sweet potato or avocado plant on a windowsill and report through the year on its success.

2. **Native American Food Preparation:** Have the students research the preservation methods practiced by different Indian tribes and write a short report describing one method and how it fit in with their way of life.

Preparation for Next Lesson:

Prepare a review of material presented in previous lessons; gather material for mural or for the popsicle community.

Organic Gardening

Organic gardening is a method of gardening that utilizes only naturally occurring materials in the food growing process. The organic gardener imitates the cycles of nature, trying not to disturb the tenuous balance of life in the soil. The soil is enriched by composting, mulching, crop-rotation and other methods that fully utilize natural processes.

A **compost** is a mixture of decomposed organic materials that can be added to soil as a natural, balanced fertilizer. Through composting we are able to return organic wastes back to their source, the soil.

Mulch is a ground covering for soil. An organic mulch, such as grass clippings, straw or newspaper, is placed on the ground around plants to 1) keep weeds down, 2) retain moisture, 3) help maintain a more constant soil temperature, 4) prevent compaction of the soil, and 5) fertilize the soil (over the long term). Various inorganic materials also can be used as a mulch like the organic mulches. A commonly used inorganic mulch is black plastic similar to the plastic used in garbage bags.

Why Organic Fertilizers?

1. **Most organic fertilizers are made of renewable resources. Examples include: livestock manure, grass cuttings, fish emulsion and bone meal.**
2. **Because they are naturally occuring elements, organic fertilizers do not contribute to pollution of waterways or other parts of the environment.**
3. **Organic fertilizers enrich the soil naturally and add to its organic base.**
4. **Most organic fertilizers contribute to a more direct food chain because organic matter is placed directly on the soil and breaks down there.**

Making a Compost

What You Need:

1. Organic Materials: There are an indefinite number of organic materials available in the country as well as in the city if we use our imaginations and seek them out. Some examples: weeds, grass clippings, kitchen garbage (no meat or citrus fruit, please), leaves, human hair, sawdust, ashes (in thin layers), coffee grounds, fish emulsion, manure, crop spoilage or surplus.

2. Proper Decomposition Conditions: Bacteria and fungi are the primary decomposers that convert the individual organic wastes into rich, homogenous humus.

3. Three Conditions are Necessary: air, moisture and warmth.

Layering of Compost:

A compost pile can be built in a contained area (such as a garbage pail or bin) or as a free-standing heap. The optimum dimension for an outside compost heap is a 5'x5'x5' cube, but similar proportional dimensions will work as well. There are many ways of building a compost pile, but for our purposes here, we will look at the free-standing layered cube.

This compost pile has three basic layers that are put down alternately in 2-4 inch layers until the pile reaches the desired size.

Plant Matter is any plant waste or product, such as weeds, kitchen garbage, leaves, corn husks, hay, straw, sawdust, wood chips. Each one of these layers should be about three times as thick as the manure layers.

Manure comes from any farm or ranch animal. Chicken or rabbit manure is extremely good for a compost. The manure can range from very fresh to well-aged or rotting. If it is difficult for you to find manure, you may add or substitute bone meal, blood meal, fish emulsion or other natural fertilizers.

Soil is a thin layer of soil at the top to retain moisture and seal the pile. Soil also can be sprinkled between the layers. Soil serves as a catalyst in decomposition.

Enrichments such as rock phosphate, granite dust, wood ash and limestone will speed up bio-chemical changes in the compost and can be sprinkled between the layers to enrich the pile.

* Meat will attract animals and can putrefy; citrus skins often are treated with fungicides which impede beneficial fungal activity.

Composting tips:

Preparing Material: To speed up the composting process, it is a good idea to chop or shred materials as fine as possible. It will increase the surface area as well as allow for better aeration of the heap. The compost should be about as moist as a well wrung-out sponge. If you are in a rainy area, cover the top of the pile with a tarp. If you are in a dry area make your pile in the shade.

Airing Your Pile: It is important to have air circulating in the heap. The primary method of aerating is to periodically turn the heap. Other methods include placing tubes in the heap as you build it; using an open lattice framework (i.e., chicken wire); or punching holes in the bottom of the compost container.

Heat in the Center: Your pile should become very hot at the center (over 100° F.) because the bacteria and fungi are breaking down the various materials into rich organic humus. When you turn, the heap, you are putting the cooler outside materials in touch with the central core of activity so that all the compost becomes homogenous.

Worms for a Healthy Soil: Adding worms to your compost pile will speed up the process; 1,000 to 2,000 worms will soon become 10,000. They mix, aerate and add their excreta to the ingredients of the compost. Worms are very important to a healthy, fertile soil; but don't add the worms until the pile has cooled somewhat!

Successful Compost

crumbly texture
black-brown color
earthlike odor
successful compost will not have an unpleasant odor.

Unsuccessful Compost

tight, packed or lumpy
grayish-yellowish; too much dead earth
musty smells; molds
sour smell; too wet, not enough air
unchanged materials; too dry

In making compost the organic gardener is trying to duplicate the cycles of life and death which take place in the soil. If we did not harvest any crop or interfere in any way, the recycling of nutrients would take place by itself. We do, however, take very substantial crops from the land, so it is necessary to return what we can – our waste. All the plant and animal products that originate from the soil can be returned to the soil, completing the circle and keeping the system healthy and productive.

Other Organic Fertilizers

Many of the ingredients of compost can be used separately as fertilizers. You may work them into the soil, lay them down as mulch, or simply apply them around growing plants as a side dressing. These materials should be used whenever you wish to improve the fertility of the soil or give your plants a boost. Some examples:

Bone Meal is crushed bone which comes in powder form. This can be sprinkled around growing vegetables as a side dressing.

Blood Meal is dried blood in powder form. This is very high in nitrogen (12-15 percent) and should be sprinkled sparingly.

Fish Emulsion is a liquid fertilizer made from fish and fish by-products. A capful should be diluted in one gallon of water and poured around plants. This is a good source of nitrogen and phosphorous.

Granite Dust is a very good source of potash and can be added directly to the soil or as a side dressing.

Rock Phosphate is a powder made from crushed rock, high in phosphorous, calcium, iron, sodium, magnesium, boron and iodine. Good directly in soil and as a side dressing.

Wood Ash can be used to add alkalinity to soil or compost. It makes a very good mulch and is a good source of phosphorous and potash.

Manure is a very important component in compost and can be used directly in soil as well. Cow, horse, goat, pig, chicken, sheep and pigeon are all possible sources of manure for the organic gardener. Dried manure is always richer in nutrients than fresh, but often it is easier to obtain a fresh source and the rule should be: choose the materials which are easily obtainable in your area at a minimum cost. *One precaution:* Fresh manure or manure which has not been aged may burn your plants and should be used with discretion as a mulch only. Apply it to the soil in the autumn or use it in the compost pile.

Green Manure is a crop grown specifically for soil improvement, especially legumes such as clover. The plants can be turned under, used as mulch or layered in the compost.

1. Most organic fertilizers are made of renewable resources. Examples include: livestock manure, grass cutting, fish emulsion and bone meal.

2. Because they are naturally occurring elements, organic fertilizers do not contribute to pollution of waterways and other parts of the environment.

3. Organic fertilizers enrich the soil naturally and add to its organic base.

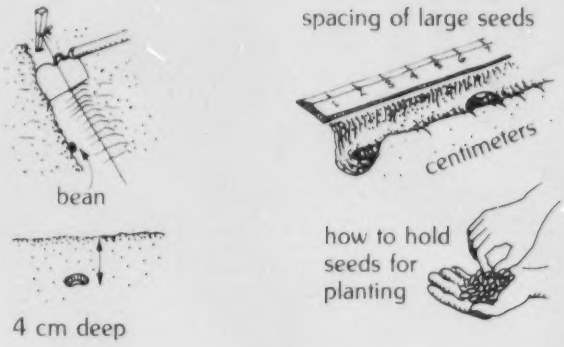
4. Most organic fertilizers contribute to a more direct food chaine because organic matter is placed directly on the soil and breaks down there.

TIPS FOR A SUCCESSFUL GARDEN

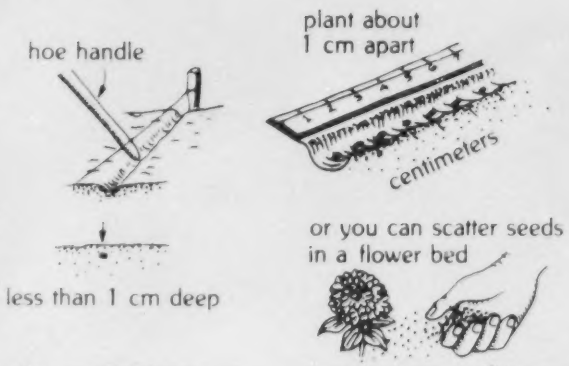
1 DIGGING AND FERTILIZING THE GROUND OF THE PLANTING PLACES

the lump test for soil condition
too wet
ready to work
dig each furrow full width of the garden
scatter fertilizer evenly and lightly
hoe forward

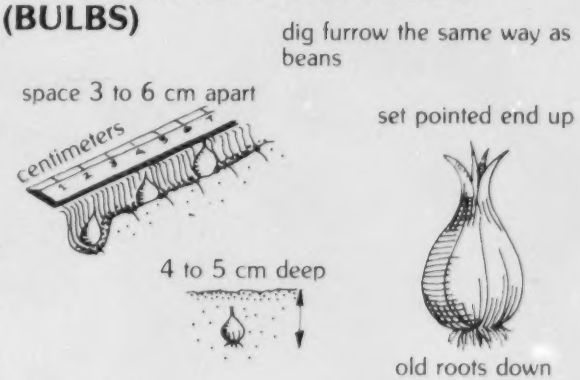
2 PLANTING GREEN BEAN SEEDS



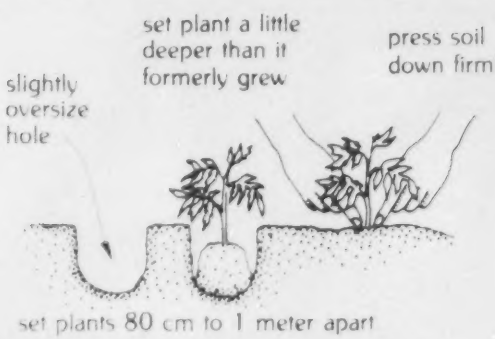
3 PLANTING ZINNIA SEEDS



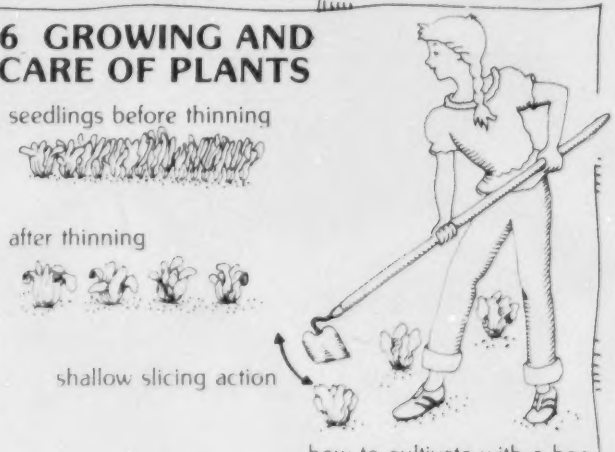
4 PLANTING ONION SETS (BULBS)



5 PLANTING THE TOMATO PLANT

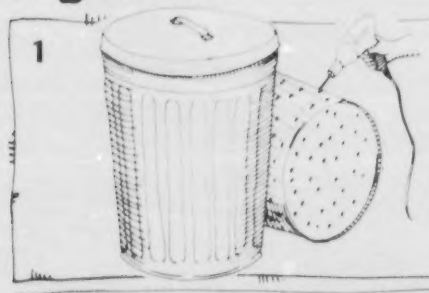

set plant a little deeper than it formerly grew
press soil down firmly
slightly oversize hole
set plants 80 cm to 1 meter apart

6 GROWING AND CARE OF PLANTS



* *From Cleveland Public Schools, Horticulture Department.*

HOW TO MAKE GARBAGE PAIL COMPOST



1 DRILL HOLES IN THE PAIL

Use an electric drill that holds a 3/8" drill bit and make 30 or 40 holes through the bottom and lower sides of the pail as shown.

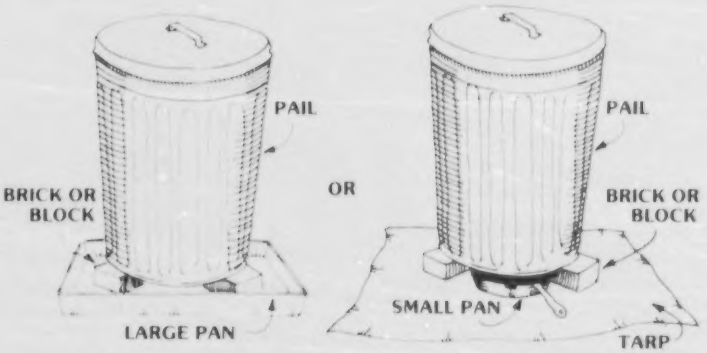
If you don't have an electric drill, have someone do it for you that has one, since this is the quickest and neatest way to make the holes.

2 SET UP THE PAIL

Since this may be a rather messy project, choose a place that won't be bothered by a composter.

Stand the pail on bricks or blocks so that you can collect the organic solution that will run out of the holes in the pail. This solution, also called "Organic Tea" can be diluted with water and used to water plants.

If you find a large enough pan, you can place the pail, bricks and all, into it. If not, set up the composter on a tarp or other suitable covering and catch as much of the "Organic Tea" as you can with any container that will fit under the pail as shown.



3 FILLING THE COMPOSTER

There are 3 kinds of materials to put into the composter:

A) GREEN MATTER (plant wastes, grass, weeds, leaves, hay, straw, kitchen scraps, etc.)

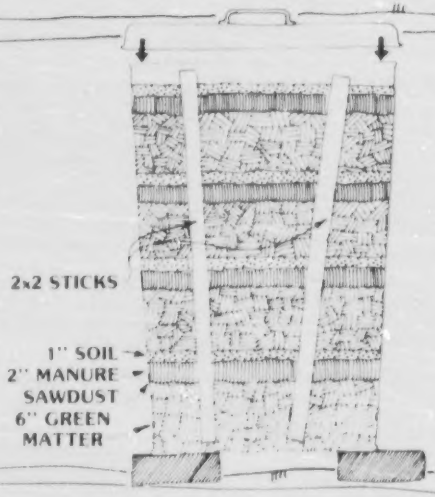
B) MANURE (fish emulsion or bone meal will work)

C) SOIL

Layer these three materials as shown. A thin layer of sawdust after each layer of Green Matter helps to reduce odor and to absorb moisture.

Place two sticks upright into the pail as shown, while filling. Chop and shred the material as much as possible to speed up the composting process.

When filled, take out the sticks (for aeration) and put the lid on.



4 COMPOST MAINTENANCE

Stir the pile once a week for aeration of the compost. It should be very hot in the center.

Keep the pile glistening moist like a sponge.

Compost should be ready in 6-8 weeks.

A successful compost has a crumbly texture, a black-brown color and earth-like odor.

An unsuccessful compost is tight, packed or lumpy, greyish yellow (dead earth) and smells musty (mouldy) or sour (too wet and dry).

Quiz for Lesson Nine

1. Name and describe three methods of food preservation.

2. Name three materials that are often used in a compost pile.

3. To break down into rich fertilizer compost does *not* need:
   a) heat
   b) air
   c) manure
   d) light

4. Compost is used by organic farmers as a fertilizer because:
   a) it is easy to transport
   b) it keeps the bugs away
   c) it is a blend of organic materials that naturally enriches the soil

LESSON TEN: A COMMUNITY OF APPROPRIATE TECHNOLOGIES

Objectives:

Students should be able to show how different appropriate technologies can be used together, and give examples of possible or real integrated appropriate technologies.

Vocabulary:

integrated technologies

Discussion of Concept:

1. **Review:** Discuss the students' perceptions of appropriate technology now that they are more familiar with it. What do they think about the different concepts and processes? Do they think appropriate technologies will play a larger role in the future, or will their impact be minimal? What appropriate technologies could be used in their area, but aren't? Why aren't they? In what ways do they practice principles of appropriate technology? Do they ride their bikes or walk rather than asking their parents for a ride? Do they buy a recyclable can or a returnable pop bottle? Do they make the best use of renewable and nonrenewable resources? How would their town or neighborhood change if more people used appropriate technologies?

Materials Needed:

For the Mural: construction paper, glue, crayons, tin foil and newsroll end (or other material you find appropriate).

For the Popsicle Community: quantities of popsicle sticks, glue, pieces of clear plastic, tin foil, construction paper, crayons, egg cartons.

Class Activity:

1. **Mural:** Have students design their own appropriate technology community. Suggest drawing houses that face south, solar greenhouses, solar collectors to heat water, solar ovens and food dryers. Other elements of the community: windmills, community gardens, compost piles, public transportation, a recycling center, a farmers' market or food cooperative, small stores, a community center for recreation. Cut out the drawings and paste them on a large piece of paper (newsroll ends available from most newspapers work well for this).

2. **A Popsicle-Stick Community:** A community made with popsicle sticks can be constructed to demonstrate appropriate technologies. This project involves a little more preparation and time to complete (probably two hours or more) than the mural. Students build individual models of buildings, hot water heaters, windmills, etc. – a good project if you have the time and interest.

Quiz for Lesson Ten

1. Look at the list below and match one appropriate technology with another that it can be used with.
   a hydro dam
   a community canning project
   a compost pile
   a windmill
   recycling
   a wood burning stove
   solar collectors
   community gardens

   Explain how each pair of appropriate technologies work together.

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*Bibliography courtesy of the Center for Renewable Resources, Washington, D.C., from their "Solar Energy Education Bibliography."

For further reference:

The American Museum of Science and Energy, Oak Ridge Associated Universities, P.O. Box 117, Oak Ridge, Tenn. 37830; (615) 576-3211.

The Museum publishes "Science Activities in Energy," a series of simple but effective science experiments designed for the 4th through 6th grade level. These packets offer some of the best graphic illustrations available and include projects in chemical energy, conservation, electrical energy, solar energy and wind energy. The Museum also has developed material for secondary level students in solar and biomass areas. All are free.

Center for Renewable Resources, 1001 Connecticut Ave., N.W., Washington, D.C. 20036; (202) 466-6880.

The Center has published a "Solar Energy Education Bibliography" and a "Solar Energy Education Packet," and also has available films, filmstrips, slides and audio visuals and other publications in the solar area, K-college. The bibliography is especially worthwhile for the elementary grades. We have drawn from it for our children's bibliography.

Earthwork, 3410 19th Street, San Francisco, Calif. 94110; (415) 626-1266.

Earthwork Books offers a catalog that lists material available in food policy and nutrition, as well as teacher aids and education material in the same areas.

Energy and Education Action Center, U.S. Office of Education, Room 514, Reporters Building, 300 7th Street, S.W., Washington, D.C. 20202; (202) 472-7777.

A clearinghouse for energy-oriented educational material, the Center has a "Selected Bibliography of Energy and Education Materials." The bibliography includes fact sheets produced by the National Science Teachers' Association, Department of Energy curricula, and other pertinent curricula developed on the state level.

Environmental Action Reprint Service (EARS), Box 545, La Veta, Colo. 81055; (303) 742-3221.

EARS is a mail order operation, offering a large selection of material spanning energy, food policy and gardening. A brief section on teaching materials also is found in EARS' catalog, but nearly all the educational listings can be obtained by writing directly to sources listed here (i.e., Center for Renewable Resources, National Wildlife Association). However, the catalog is a worthwhile reference for the adult who wants to pursue subject matter in energy and nutrition.

National Solar Heating and Cooling Information Center, P.O. Box 167, Rockville, Md. 20850. Toll free number: (800) 523-2929; in Pennsylvania (800) 462-4983; in Alaska and Hawaii (800) 523-4700.

The Center offers solar bibliographies for children and young adults, grades K-12, as well as a listing of manufacturers and suppliers of educational solar products.

The National Wildlife Federation, 1412 16th Street, N.W., Washington, D.C. 20036; (202) 797-6800.

The Federation's Ranger Rick series features popular stories for children, including "The Best Present of All," and "A Place for the Children." Beautifully illustrated and presented as separate magazine-length articles, the stories are reprints from *Ranger Rick Nature Magazine*. One copy of each is available free. The Federation also offers teachers' guides to ecology, K-12.

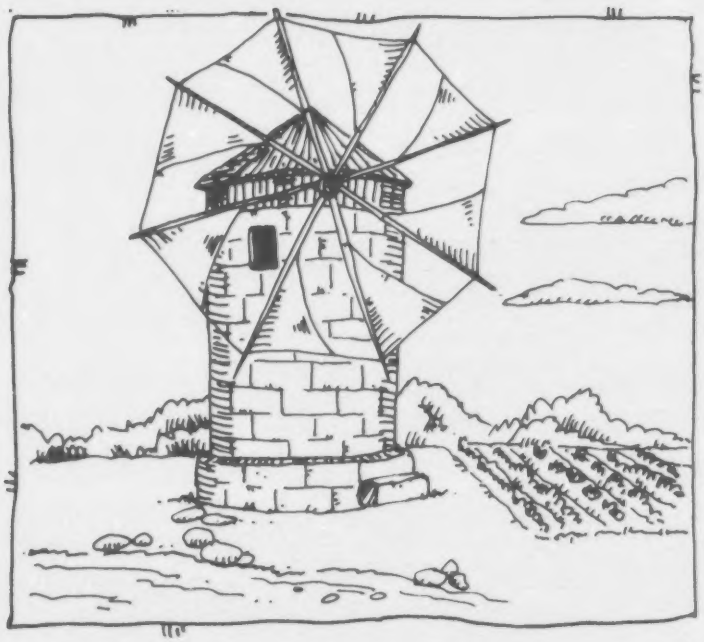
The New Western Energy Show, 226 Power Block, Helena, Mont. 59601; (406) 443-7272.

The Energy Show developed "Get Your Hands On Energy," a wide-ranging and interesting booklet of solar activities for elementary school students, while presenting a traveling energy show in Montana. The booklet is available for $5.25, including postage; a 40 percent discount will be given to orders of 10 or more. The Energy Show also sells the script from their traveling production which was aimed primarily at elementary students; cost is $3.25, including postage.

U.S. Department of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, Tenn. 37830; (615) 576-1301.

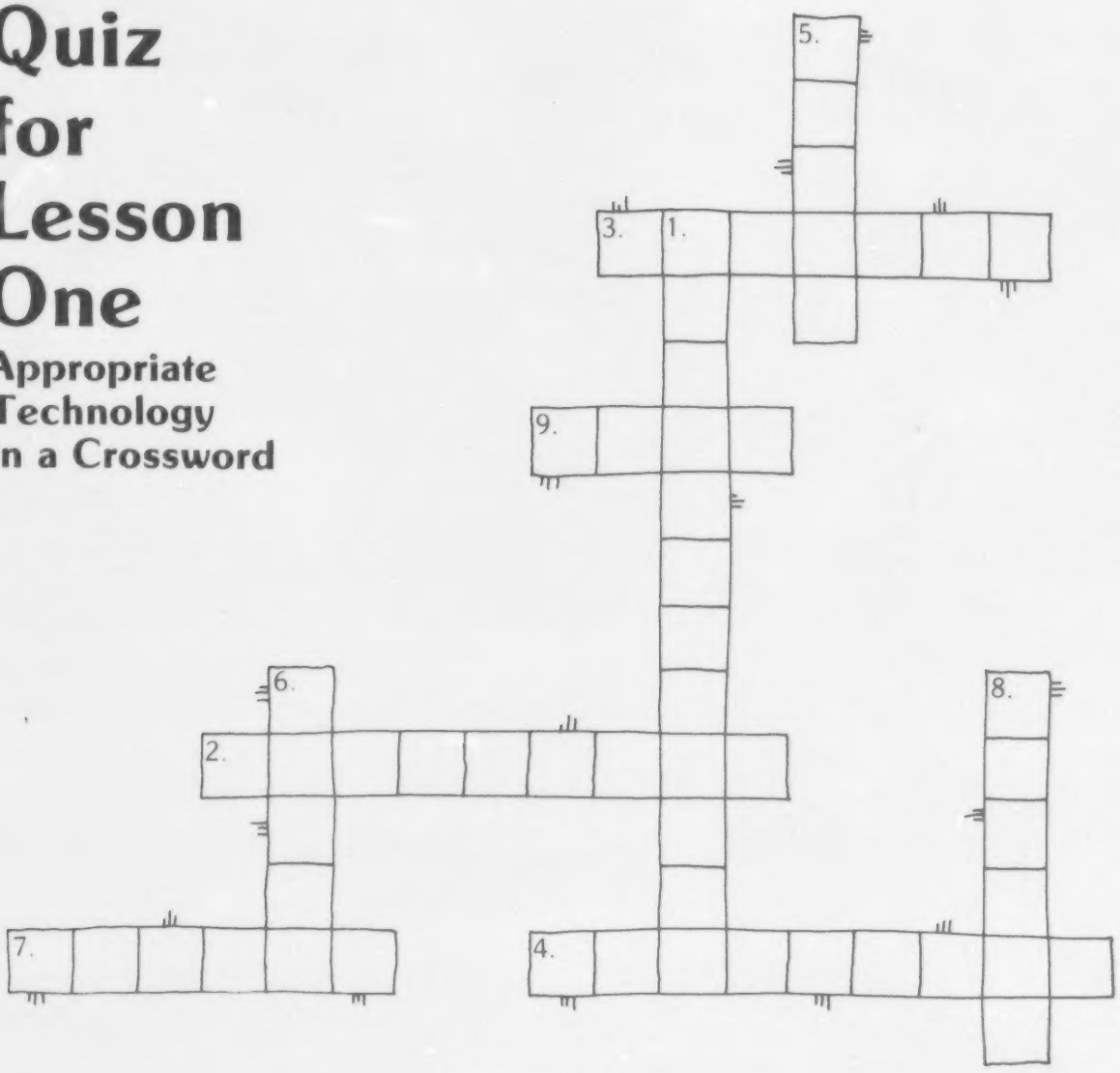
DOE offers a wide range of curricula in energy and environment areas, spanning grades K through 12. Specific subject areas are treated in separate curricula for each grade level. Also available are: a bibliography of DOE and National Science Teacher's Association education materials, posters, pamphlets, booklets and a film catalog. All materials are free.

Student Handouts



Quiz for Lesson One

Appropriate Technology in a Crossword



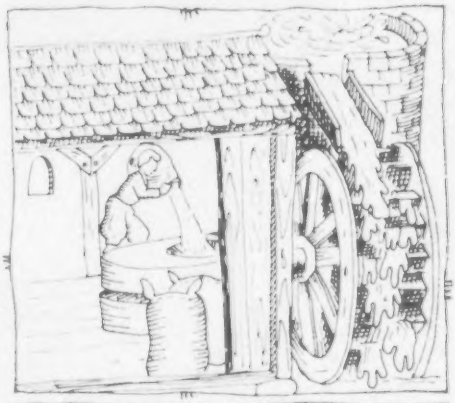
A good example of appropriate technology at work would be: a) a factory b) a community garden c) a town parade. List all the characteristics of appropriate technology that apply to the example you choose.

Fill in the crossword puzzle with characteristics of appropriate technologies.

1. Appropriate technologies stress _____ of energy. (down)
2. Appropriate technologies are part of the _____(across).
3. Appropriate technologies stress the importance of our natural world and _____. (across)
4. Appropriate technologies use _____ resources. (across)
5. Appropriate technologies can be _____ by the people who use them. (down)
6. Appropriate technologies use _____ materials. (down)
7. Appropriate technologies require human _____ . (down)
8. Appropriate technologies usually are _____ systems (down)
9. that _____ less than more complex systems. (across)

HISTORICAL PERSPECTIVE ON ENERGY

About 400,000 years ago, people learned how to use wood to make fire for heat, cooking, light and protection.

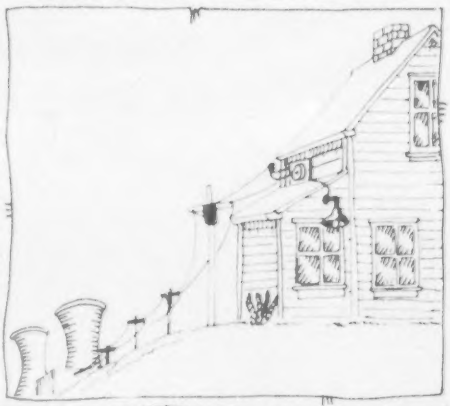


Water wheels were widely used by early civilizations. Water turned a wheel and helped people to do work, such as grinding wheat for flour.

Windmills were first used in Europe about 700 years ago. Since that time, both water wheels and windmills have been used to generate electricity.

By the 16th and 17th centuries, wood was becoming scarce in Europe. People began to turn to coal for energy. We were beginning to switch from renewable energy sources – the wind, water, and the sun – to non-renewable sources – coal, oil, natural gas.

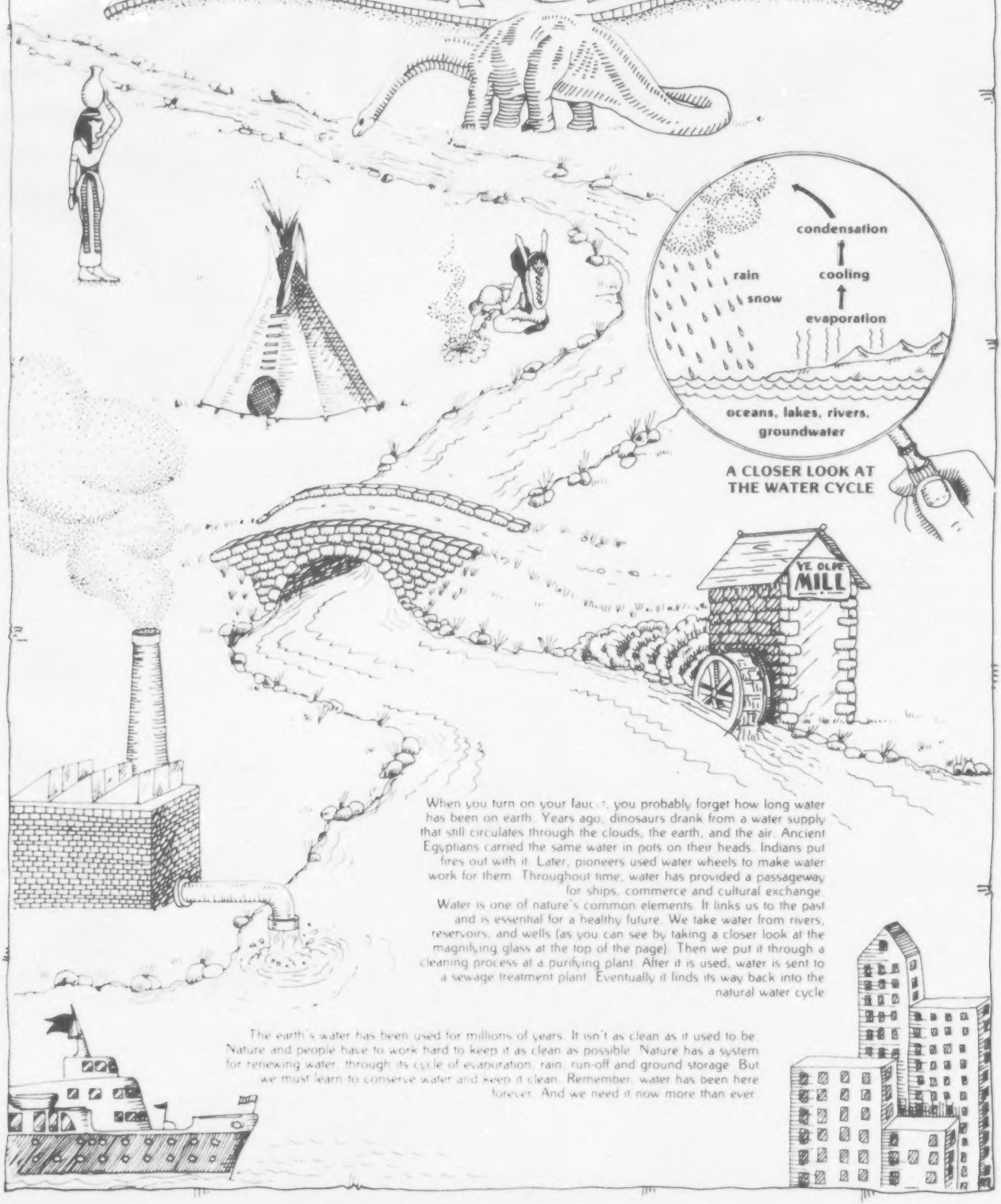
The Pennsylvania Rock Oil Co. first discovered oil in the 1850's. About 100 years later, petroleum and natural gas were widely used in the U.S. to heat homes, run factories, and generate electricity.



About 30 years ago scientists learned how to split the atom to create energy and generate electricity. Nuclear power now provides much of our electricity, but it also produces unsafe radioactive wastes. And non-renewable energy sources – oil, natural gas – are becoming scarce.

So we are again looking toward renewable sources – water, wood, the sun, the wind – to provide the energy we need.

A LOOK AT THE WATER CYCLE



When you turn on your faucet, you probably forget how long water has been on earth. Years ago, dinosaurs drank from a water supply that still circulates through the clouds, the earth, and the air. Ancient Egyptians carried the same water in pots on their heads. Indians put fires out with it. Later, pioneers used water wheels to make water work for them. Throughout time, water has provided a passageway for ships, commerce and cultural exchange.

Water is one of nature's common elements. It links us to the past and is essential for a healthy future. We take water from rivers, reservoirs, and wells (as you can see by taking a closer look at the magnifying glass at the top of the page). Then we put it through a cleaning process at a purifying plant. After it is used, water is sent to a sewage treatment plant. Eventually it finds its way back into the natural water cycle.

The earth's water has been used for millions of years. It isn't as clean as it used to be. Nature and people have to work hard to keep it as clean as possible. Nature has a system for renewing water, through its cycle of evaporation, rain, run-off and ground storage. But we must learn to conserve water and keep it clean. Remember, water has been here forever. And we need it now more than ever.

QUESTIONS TO ASK YOURSELF

1. Do you know where your water comes from? A nearby lake, river, or reservoir?
2. Is your water purified at a treatment plant before and after you use it?
3. How does nature clean water? Try and explain the natural water cycle and how it helps to purify water.
4. How much water do you use a day? How much water does your family use? Use this chart to figure it out.

Water used	Average ammount for each use	Times per day	Times per day X average amount for each use	(Times per day X average amount for each use) X (No. of people in your family).	Total
Example: (one drink of water)	1/4 gal.	4	1/4 gal. X 4 = 1 gal.	(1/4 gal. X 4) X (5 family members) = 5 gal.	
One drink, plus water run to get it hot or cold*	1/4 gal.				
Brushing your teeth once, plus water run to get it cold	1/4 gal.				
Washing your face or hands once	2 gal.				
Flushing the toilet once	3 gal.				
Bathing	30 gal.				
Taking a shower	20 gal.				
			Total:	**Total:**	**Total:**

FINAL QUESTION: Adding up the figures in the last column of the chart, how much water does your family use per day? Suppose that your family, or that you alone, could save 15 gallons of water per day. If each person in the U.S. could save this much, how much water could be saved each day? (Assume that there are 200,000,000 people in the U.S.)

* You probably would not drink 1/4 gal. of water every time you got a drink, but it would take about this much to get the water hot or cold.

THE HEAT LEAK DETECTIVE GAME

TOOLS

1) a draft detector made by taping plastic food wrap to a pencil.

2) a note pad and pencil to jot down clues and findings.

FIND THE HEAT LEAKS IN YOUR SCHOOL

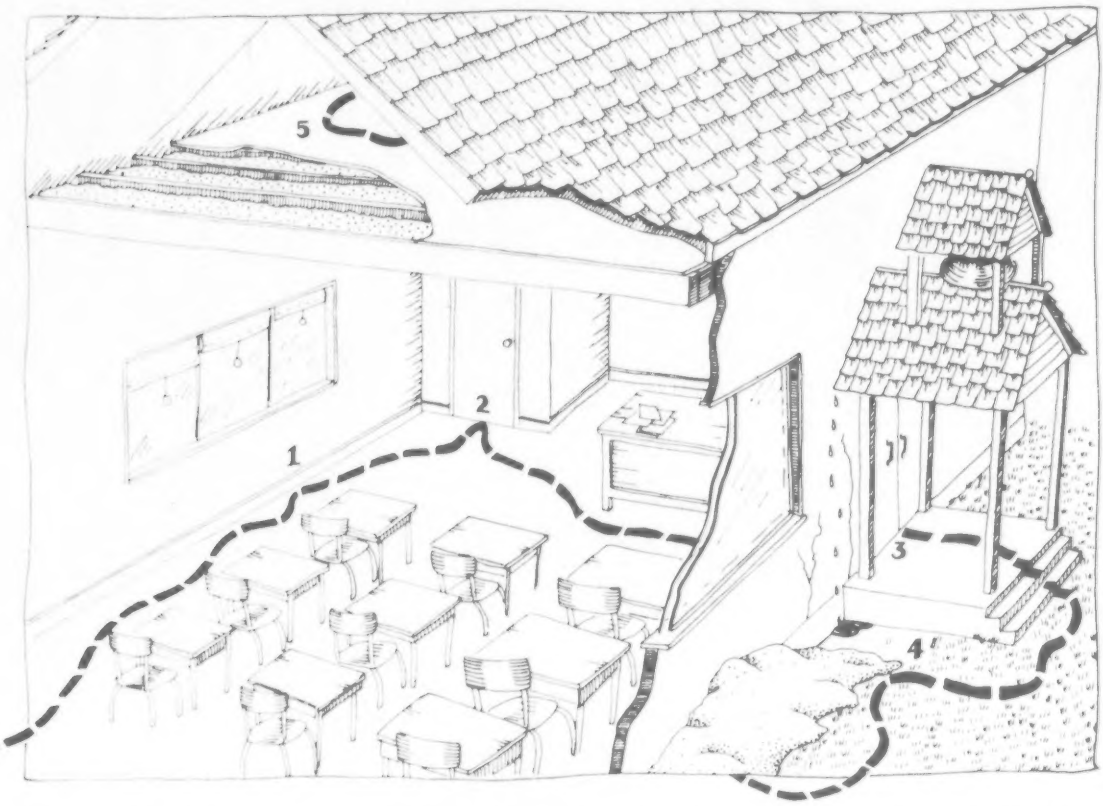
1) Search out drafts by holding the draft detector to probable leaks. Does the plastic move?

2) Write down the trouble spots and describe ways of plugging the leaks.

3) Return to class with your findings. Who in the class found the most leaks?

1 **Curtain or Shades:** Are curtains used at night to hold the warm air in? Could carpets or rugs contribute to keeping the air in?

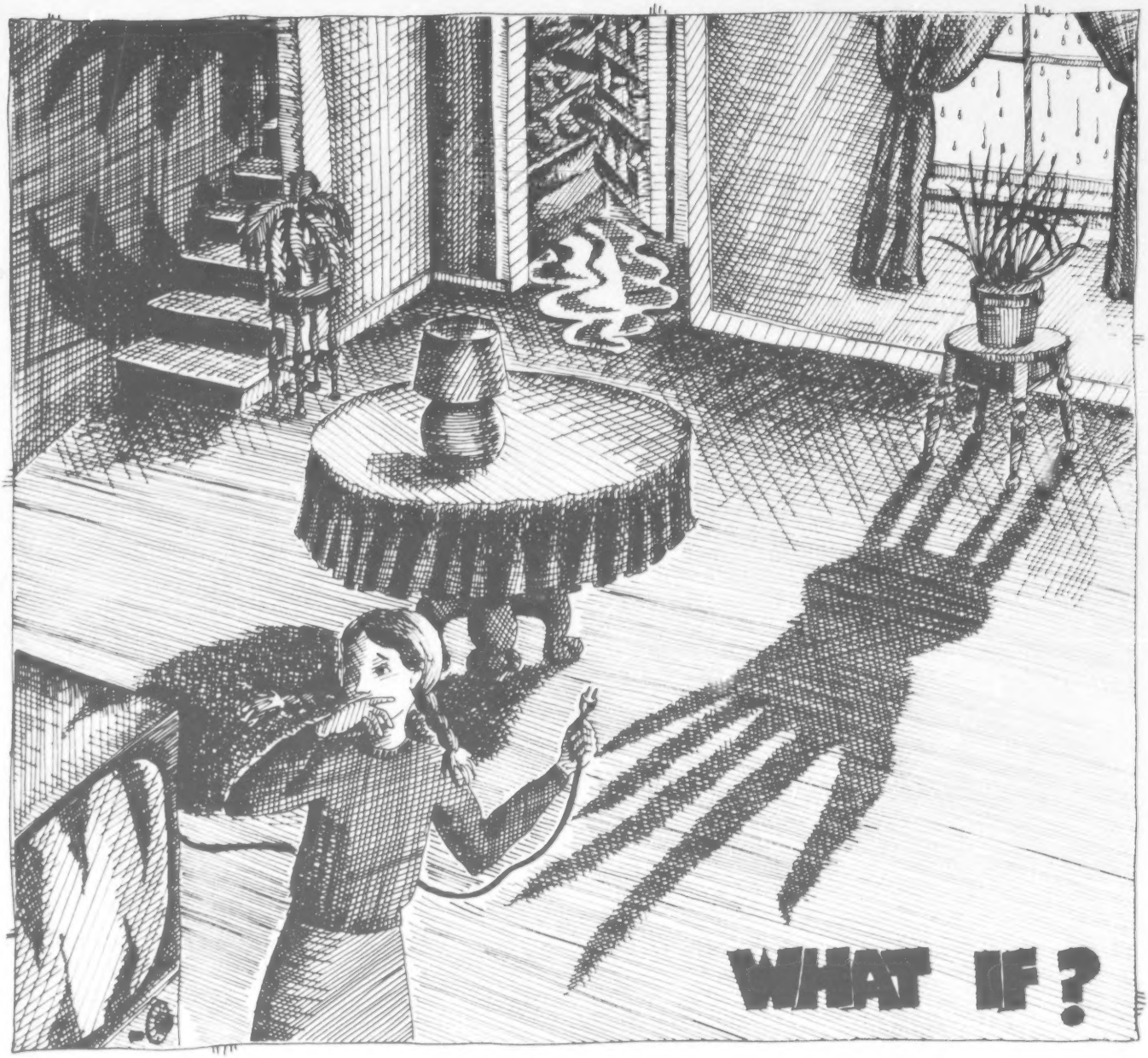
2 **Storage Rooms and Closets:** Are the doors of storage rooms and closets left open? Areas not commonly used need not be heated and should be kept shut off from other rooms. Do their doors fit tightly, or is heat leaking into them?



3 **Windows and Doors:** Are doors or windows left open for no reason? Is there weather stripping around doors, caulking around windows? Do the window frames fit tightly against the wall of the room, or is there heat escaping through cracks? Does the glass fit tight in the frame? Are storm windows used in the winter? Are double-glass entrances used, with each door kept shut when the other is in use?

4 **Outside the School:** Are there cracks in the brickwork or related breakage or disrepair in other construction materials? Earth piled against the wall can allow damp to penetrate the walls, requiring unnecessary heating. Is there water dripping or splashing against the wall? Do the windows and doors fit tightly from the outside?

5 **The Roof or Attic:** Is there insulation? Is the structure solid and closely fitted? Are there gaps or cracks in the material? Is there a structural air gap?



Imagine coming home from school one afternoon. It is a cold, rainy day. You walk in the house and it seems cold. No lights are on. You go to the refrigerator for a snack. The light doesn't go on when you open the door and the milk carton you take out doesn't feel very cold. You turn the television on, but there is no sound, no picture. You check the cord. It's plugged in. Soon you realize there is no electricity in your house; in fact, the whole neighborhood is experiencing a blackout. No one knows when the power will be restored.

Write a story describing what happened to cause the blackout and how the people in your neighborhood react to it. There will obviously be many disadvantages. Can you imagine any good things that could come from a blackout?

How Much Does Transportation Cost?

Imagine there are 20 people who are taking a short trip to town. The total distance, coming and going, for the trip is five miles. Each of these people owns a car that goes 20 miles on one gallon of gasoline. A gallon of gas costs $1.25.

If each person drives alone on the five-mile trip, what is the total amount of gasoline that would be used? _____

How much would the gasoline for the 20 separate trips cost? _____

How much gas would each person use? _____

How much would each person spend? _____

Let's say only half the cars made the trip to town. Two people are riding in each car to save gas.

How much gasoline would be used in the 10 trips? _____

How much would the gasoline cost? _____

How much gas would each person use? _____

How much would each person spend? _____

What if four people decided to go in one car? _____

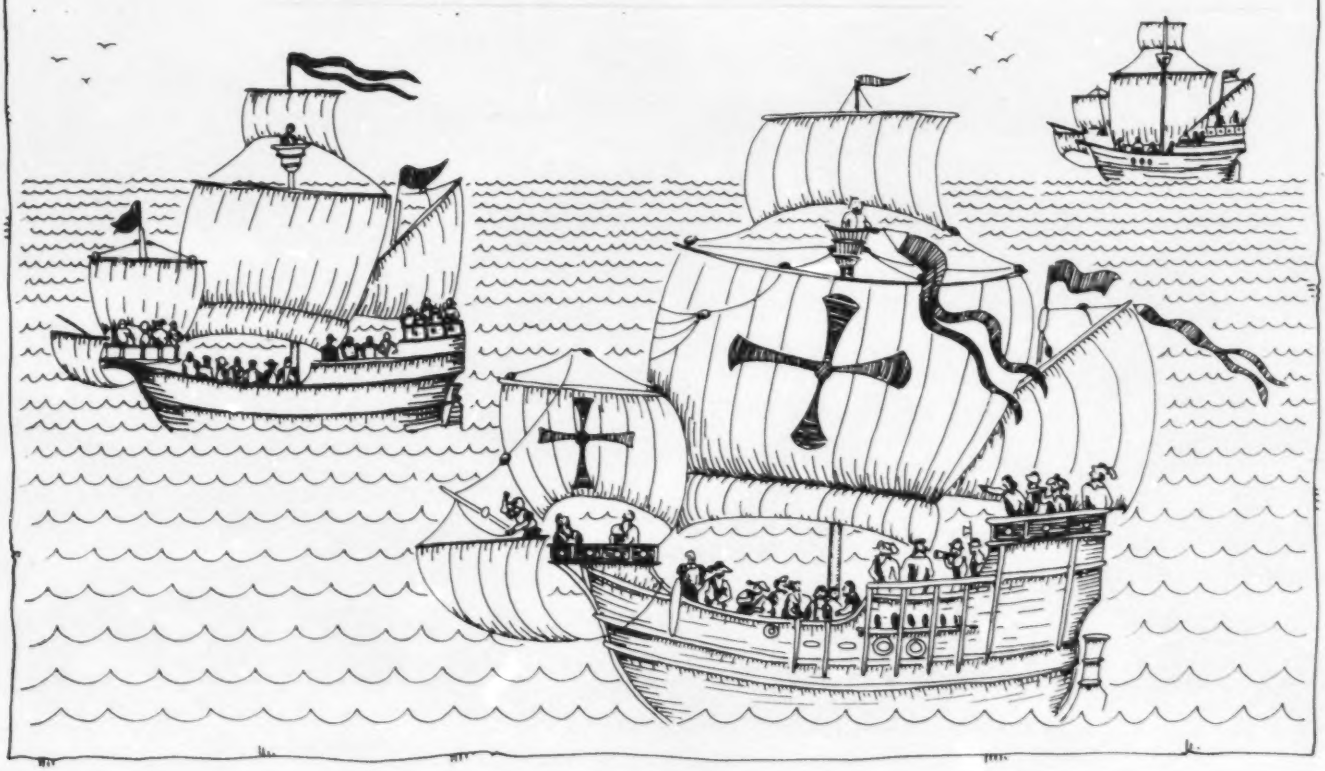
How much gasoline would be used in the five trips? _____

How much would it cost? _____

How much gas would each person use? _____

How much would each person spend? _____

DID COLUMBUS COME ON MASS TRANSIT?



Think of a form of mass transit used in historic times. The further back in history you can go, the better. Examples might be: the electric streetcar, the covered wagon, the ships that brought the pilgrims to America, the gondolas in Venice.

Read and research what you can about that form of transportation. Write a short report that explains how that form of transportation reflected the time it was used in history.

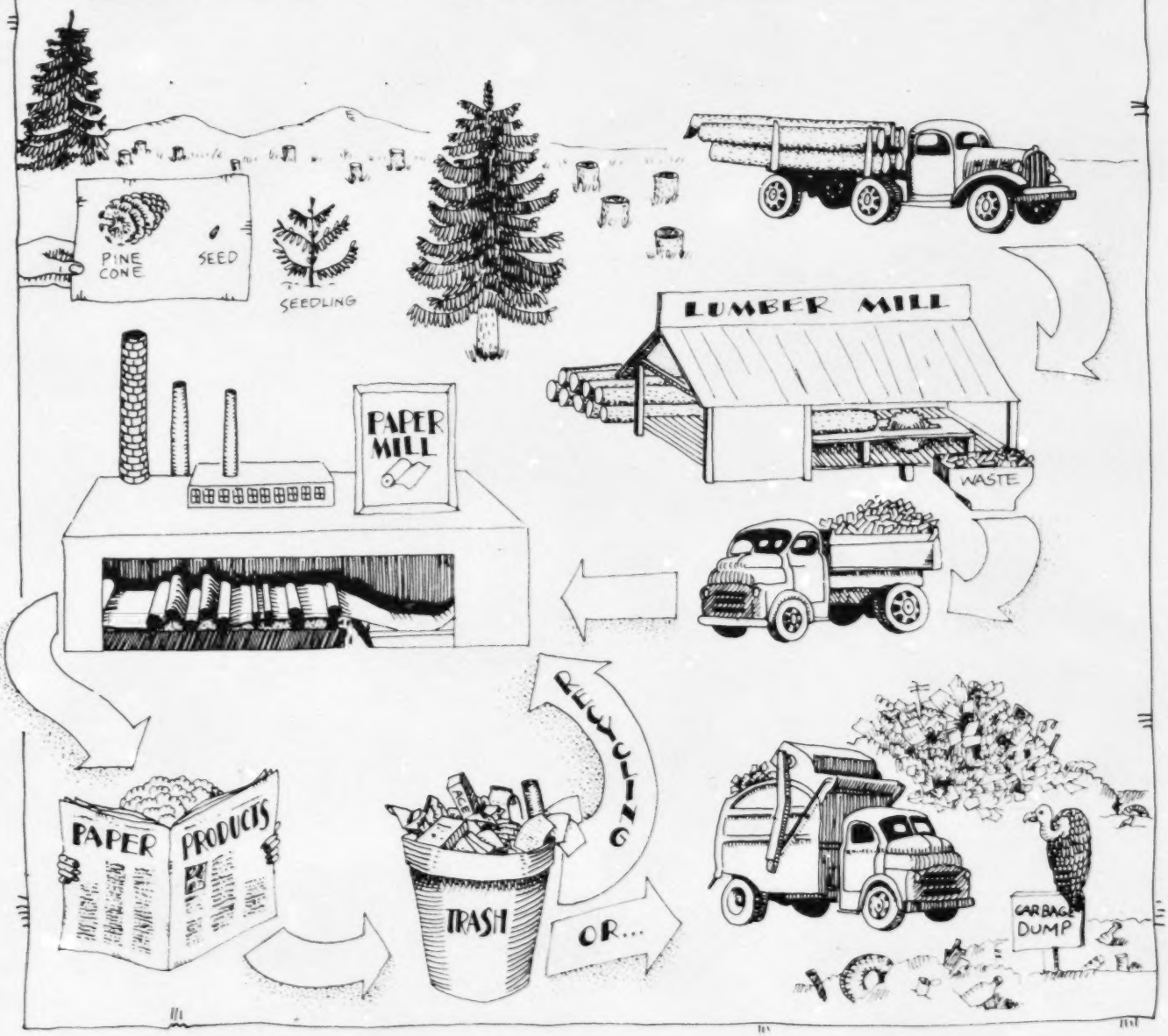
Did it contribute to changing the times? How?

Did it change, in any way, the way people lived? What were the changes and how important were they?

Did this form of mass transit contribute to our way of life now? How?

GROWTH OF GARBAGE
AVERAGE AMOUNT OF PAPER USED IN U.S.
BY 1 (ONE) PERSON ANNUALLY
1900
58
lbs.
1973
639
lbs.
920 lbs.
PAPER
440 lbs.
FOOD &
YARD
WASTES
200 lbs.
GLASS
160 lbs.
METALS
140 lbs.
WOOD
140 lbs.
CLOTH, RUBBER
PLASTIC, LEATHER
=
1
TON
GARBAGE

DON'T THROW YOUR TREES AWAY



Each ton of paper that is recycled replaces and preserves an acre of harvestable trees.

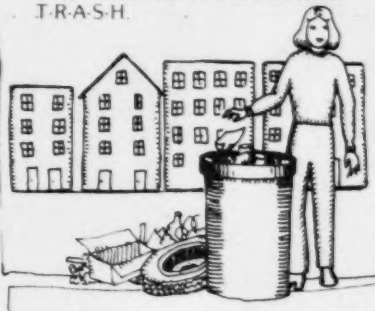
The recycling of paper reduces waste and garbage pollution.

Recycling old paper uses 50 percent less energy than making new paper from trees.

A VERY SHORT HISTORY OF TRASH

1 People have always had trash. Only Cavedwellers didn't have a big problem with it. In those days, there was plenty of room for trash. And nature easily disposed of it.

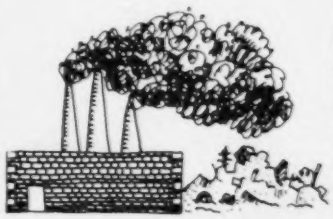
2 Today, trash is a big problem. More people mean more trash and more different kinds of trash. You name it — cans, paper, bottles, garbage, old cars, old clothes. In time it becomes T-R-A-S-H.

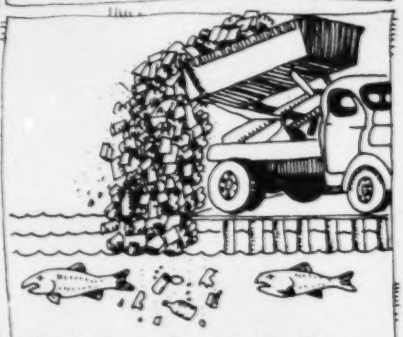


3 Every year, each one of us throws away almost ONE TON of trash. If you piled this trash in your living room, it would come to your shoulders.

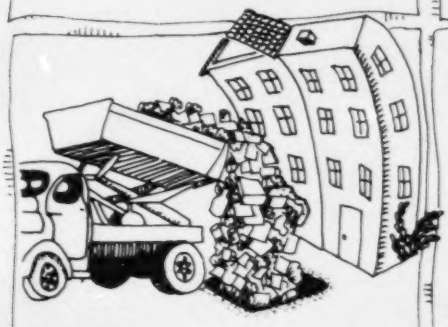
4 In one year, all our trash amounts to 360,000,000 tons. We have problems with trash that Cavedwellers never had. To get rid of it, we have tried to...

5 ...burn it. But burning trash can cause air pollution.



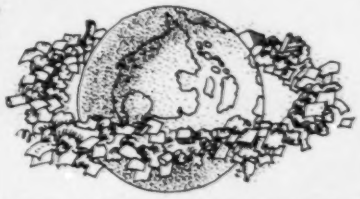


6 ...dump it in the ocean. But dumping can pollute the ocean, too.



7 ...bury it. But we're running out of empty land near cities.

8 Some scientists have even suggested shooting it off into empty space. But who wants old tennis shoes and pop cans orbiting the earth?



9 In the past few years, however, we have found a new way to get rid of some of our trash. It's called RECYCLING.

Recycling means reusing our trash instead of getting rid of it. This solves the problem of what to do with our trash and it also helps us with another problem. By using the same materials over and over again, we save our natural resources.

Recycling means shredding old cans and cars and melting the pices to make new metal for new cans and cars...

...chopping up grass cuttings and garbage to burn for energy or to make fertilizer to help new plants grow...

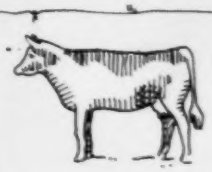
...crushing bottles into tiny glass bits and melting these bits to make new glass.

* *Concept provided by McDonald's Corp.*

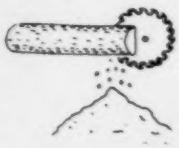
RECYCLING

INDUSTRIAL & AGRICULTURAL WASTES

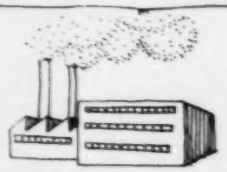
CROPS & WASTES



LIVESTOCK MANURE



WOOD PRODUCT WASTE



FACTORY STEAM WASTE

CONVERT TO ETHANOL

CONVERT TO METHANE

CONVERT TO METHANOL

CAPTURE STEAM

AUTO & TRUCK FUEL

HOUSEHOLD COOKING & HEATING

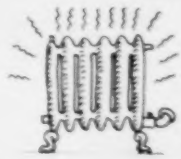
AUTO & TRUCK FUEL

GENERATE POWER

BY-PRODUCT: ANIMAL FEED

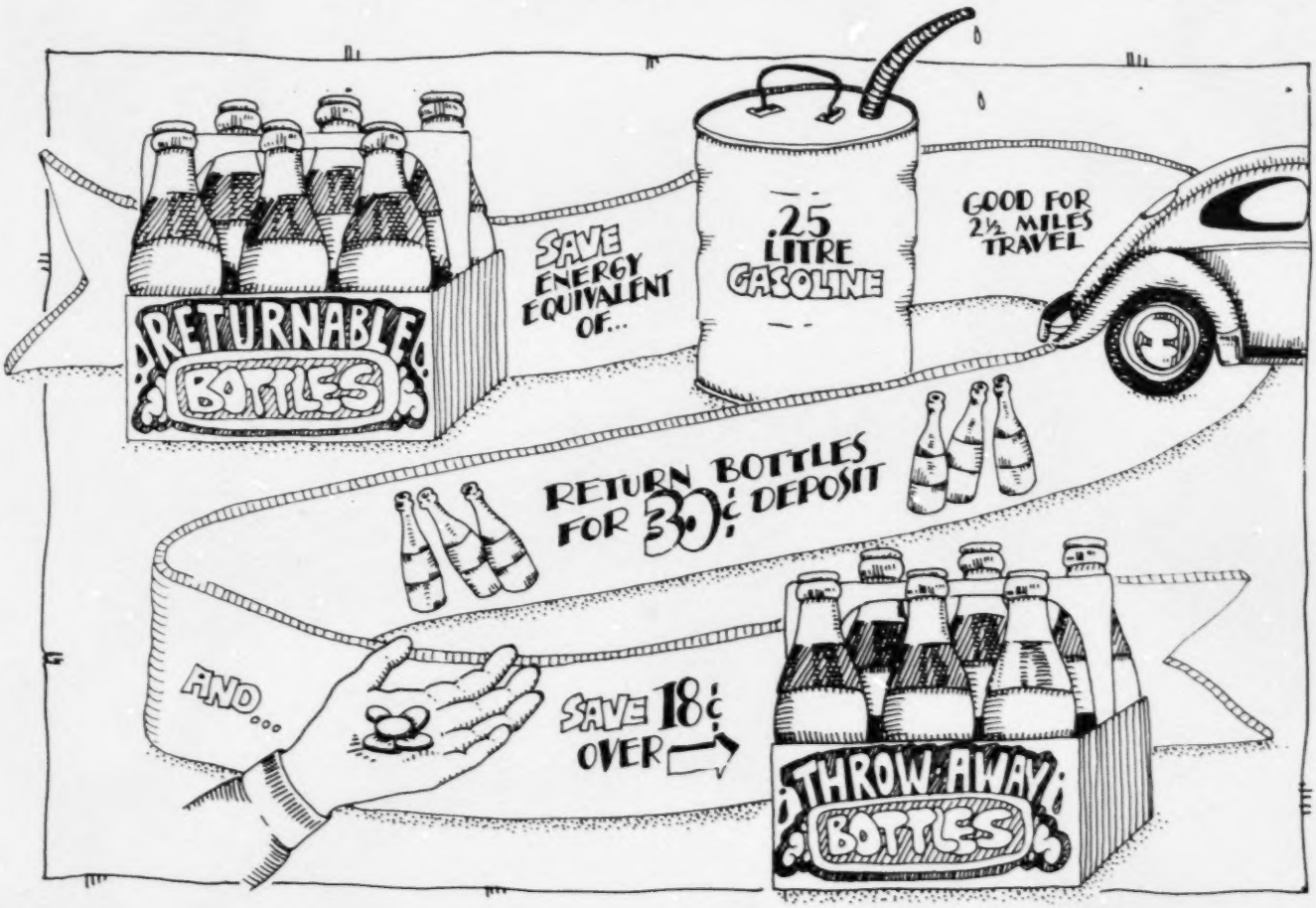
BY-PRODUCT: FERTILIZER

PLASTICS PRODUCTS



HOUSEHOLD & INDUSTRIAL HEATING

DO RETURNABLE BOTTLES SAVE ENERGY?

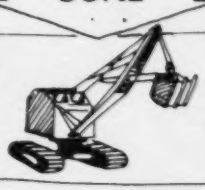
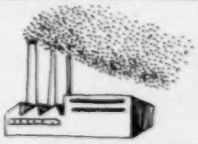
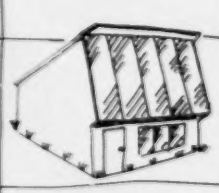
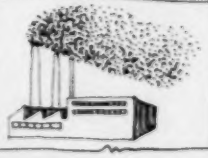


The purchase of a six-pack of soft drinks in returnable bottles instead of no-deposit no-return containers will save the energy equivalent of .25 liters of gasoline. The saving of .25 liters of gasoline can take the average family car about 2 ½ miles. In addition, when the empty bottles are returned for a 30-cent deposit, the six-pack purchase will have cost 18 cents less than for throw-aways.

1. If each family in the class purchased one or two six-packs of returnable bottles each week for one year, how much energy in gasoline will be saved?
2. Using the figure from No. 1, how many miles of automobile travel are possible with the energy which is saved?
3. How much money is saved?
4. Why do you think so many people still buy beverages in throwaway containers?
5. What do you think the government or people should do about this matter? What will you do?

* *From Iowa Energy Policy Council's* **Energy Conservation Activity Packet**, Grade 6.

ENERGY
STEPS TO A WARM HOME

	NUCLEAR	COAL	HYDRO	SOLAR
MINING				
LAND RECLAMATION				
TRANS-PORTATION				
ENRICHING				
TRANS-PORTATION				
GENERATING				
TRANSMISSION				
WARM HOME				
WASTE & POLLUTION				

THE SUN

SOURCE OF SYMBOLISM AND INSPIRATION

The sun has been an inspiration to people. Egyptians believed the sky was a falcon. One eye was the sun; the other was the moon.

The Inca Indians of ancient Peru worshipped the sun. When the sun went down at night it swam under the earth until morning when it rose again.

The Aztec Indians of ancient Mexico also believed the sun was a powerful god. They built their calendar around it.

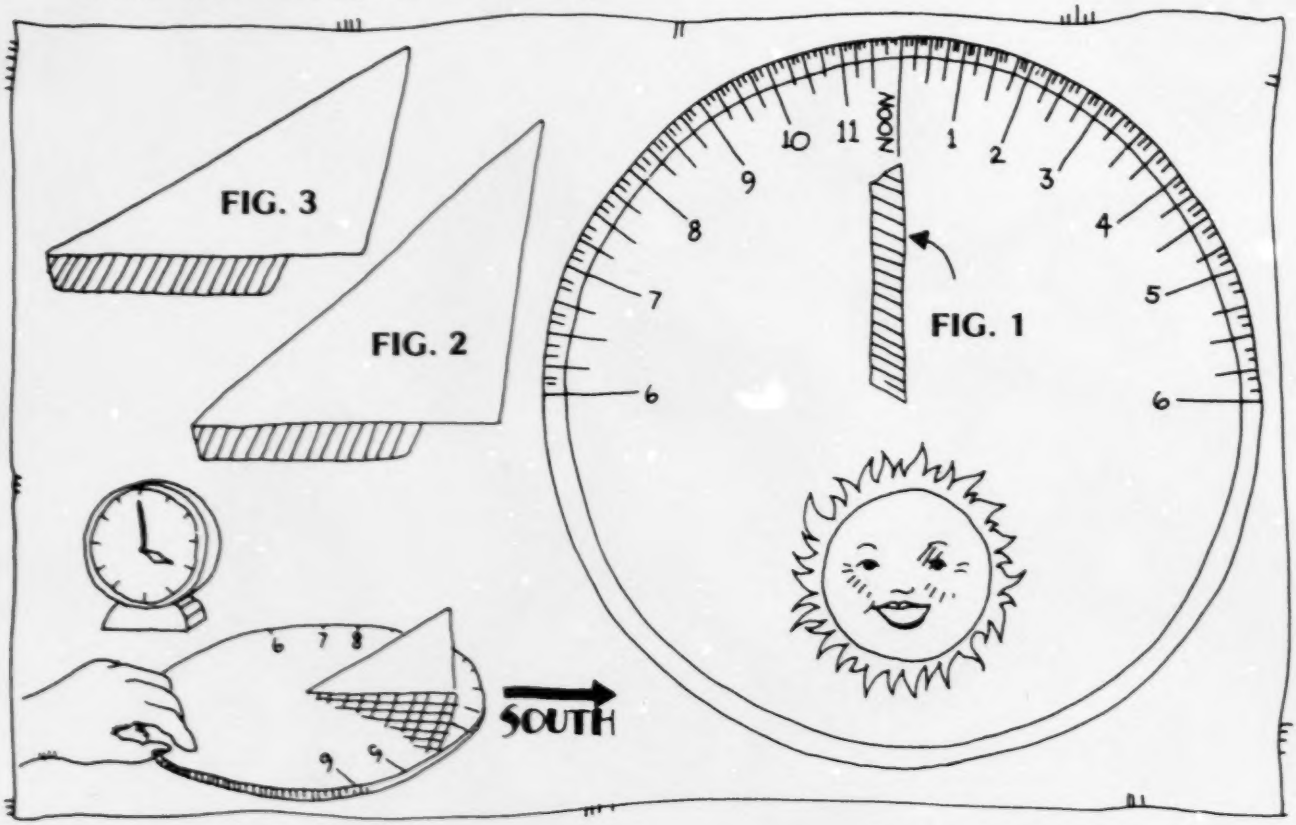
Artists in northern Europe in the 15th and 16th centuries pictured the sun as a happy, caring face.

In Japan, some people welcome the sun each morning by clapping their hands.

And in some towns in Europe, men still follow an age-old custom. They tip their hats to the rising sun.

HOW TO MAKE A SUN DIAL

If you live in the North cut out figures 1 and 2; if you live in the South cut out figures 1 and 3. Use rubber cement to glue the paper figures to a piece of cardboard; cut along the lines through the paper and the cardboard. Use a sharp knife or other tool to cut through the cardboard circle where shown. Insert the base of the triangle (gnomon) through the circle (dial) so it stands at a right angle with the gnomon aligned directly along the noon axis. Bend and glue the gnomon to the back of the dial.

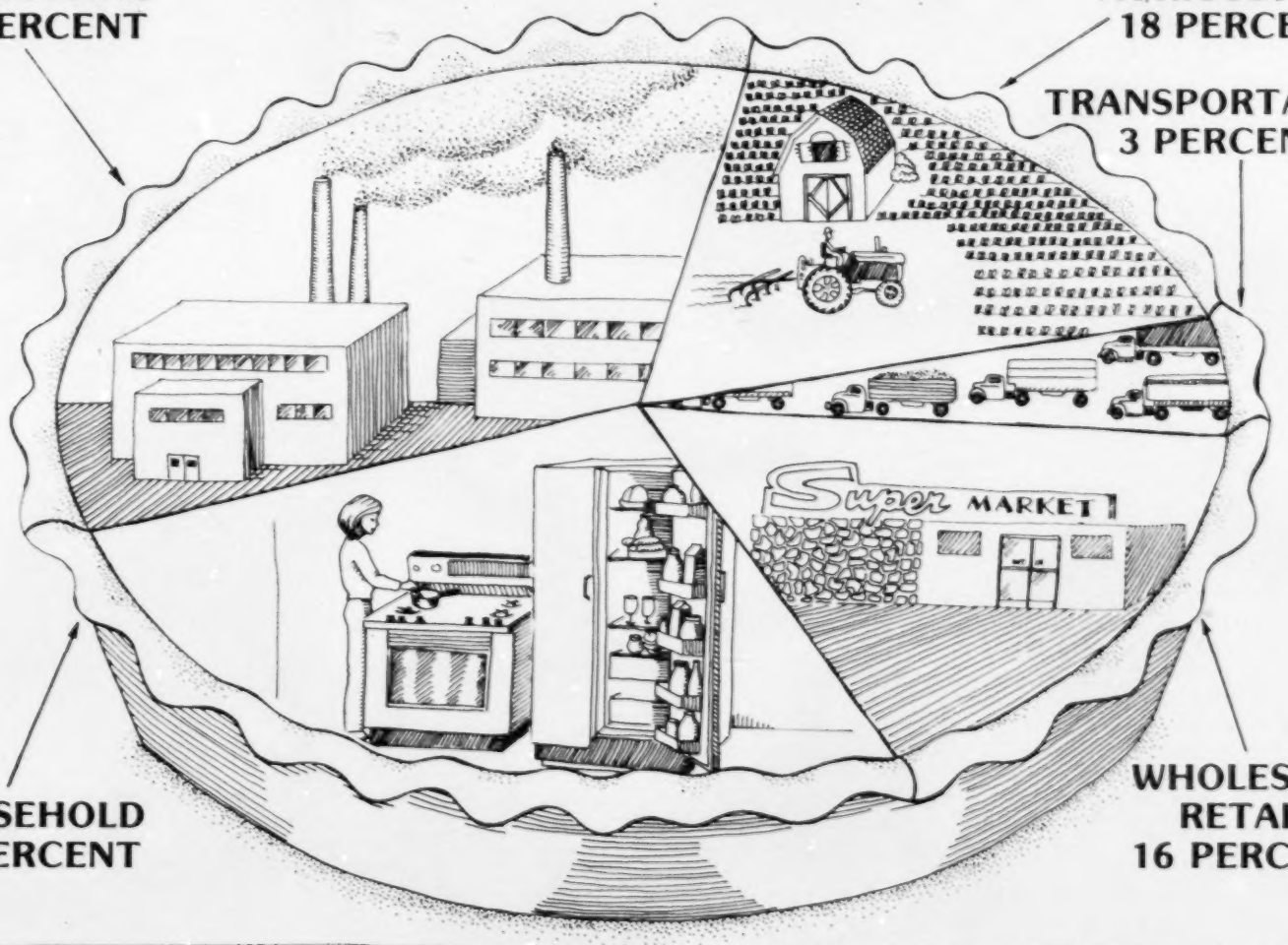


Be sure the dial is kept directly aligned along the noon axis. Otherwise the shadow cast by the gnomon will be off. To determine true North point the sun dial in a northerly direction; look at the time and position the dial so the correct hour shows on the dial. **Remember**: The sun knows no daylight savings time. If you are using an adjusted time frame, base your time of day on standard time and set the dial to North accordingly. Pick a place for the dial that you know will receive sun throughout the day. Be sure your dial is secure and won't be moved by wind, weather or living things. Check the dial at different times of the day to see if it is keeping good time.

There are a few factors that could throw your sun dial off slightly. We all live in time zones; your location in the zone could effect in a small way the time the sun dial gives you. Also, the angle of your gnomon may not be precisely correct for your latitude. The gnomon cut-outs are angles that reflect the number of degrees of latitude for average U.S. North and South locations. (North: 45 degress; South: 30 degrees). If your latitude varies far from either of these angles you might want to measure another angle that precisely reflects your latitude and cut the gnomon to that size.

ENERGY AND OUR FOOD SYSTEM

17 percent of the Total U.S. Energy Supply Goes to Food Production Processing, Transportation and Storage



WHAT CONTAINERS SAVE ENERGY?

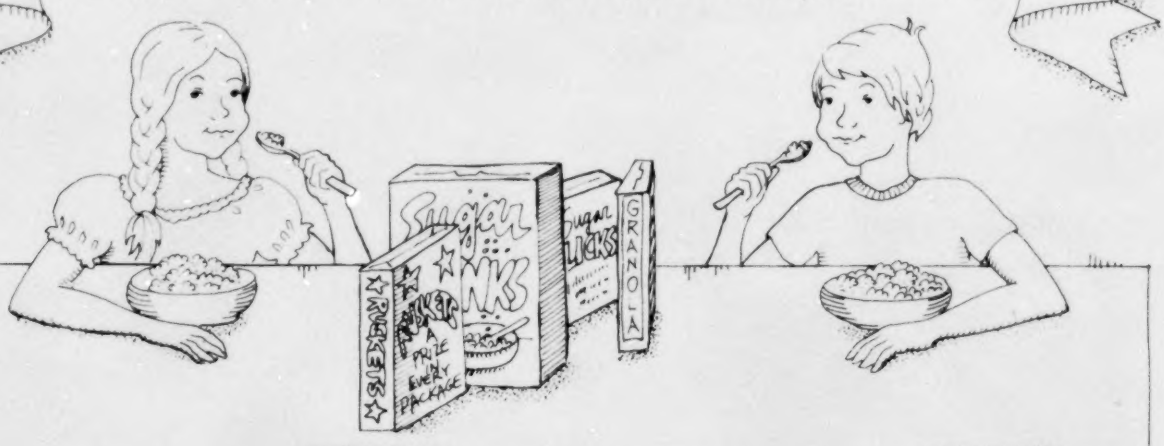
Kilowatt (kw) = 1,000 watts
Kilowatt hour (Kwh) = 1,000 watts on for 1 hour
860 food calories = 1 kwh

Energy Needed to Make Container	Container	Renewable	Reusable	Biodegradable	Recyclable
1.42 kwh	returnable pop bottle		X		X
.85 kwh	non-returnable pop bottle				X
.24 kwh	milk carton	X		X	
.58 kwh	steel can			X	X
1.28 kwh	aluminum can				X
.84 kwh	paper cup	X		X	X
.25 kwh	styrofoam cup				
1.42 kwh	mason jar		X		X

IS THERE MORE ENERGY IN THE POP OR THE BOTTLE?

Energy Needed to Make Container	Container	Energy We Get in Drinking the Contents
1.42 kwh	pop bottle	.10 kwh
.24 kwh	milk carton	.19 kwh
.58 kwh	steel can (tomato juice)	.05 kwh
.84 kwh	paper cup (coffee)	.001 kwh

PERCENT OF SUCROSE IN READY-TO-EAT BREAKFAST CEREALS

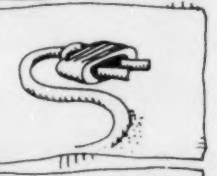
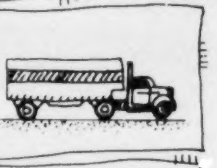
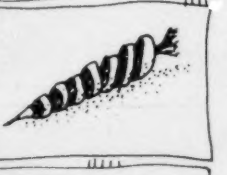
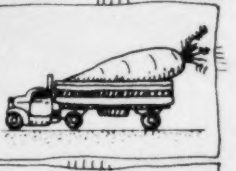
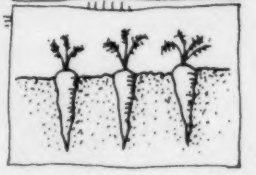


NAME	PERCENT SUCROSE
All Bran	20.0
Alpen	3.8
Alpha Bits	40.3
Apple Jacks	55.0
Baron Von Redberry	45.8
Boo Berry	45.7
Bran Buds	30.2
40 Percent Bran Flakes (Kellogg)	16.2
40 Percent Bran Flakes (Post)	15.8
100 Percent Bran	18.4
Brown Sugar-Cinnamon Frosted Mini Wheats	16.0
Buck Wheats	13.6
Cap'n Crunch	43.3
Cheerios	2.2
Cinnamon Crunch	50.3
Cocoa Krispies	45.9
Cocoa Pebbles	53.5
Cocoa Puffs	43.0
Concentrate	9.9
Corn Chex	7.5
Corn Flakes (Food Club)	7.0
Corn Flakes (Kellogg)	7.8
Corn Flakes (Kroger)	5.1
Corn Total	4.4
Count Chocula	44.2
Crisp Rice	8.8
Crispy Rice	7.3
Crunch Berries	43.4
Fortified Oat Flakes	22.2
Frankenberry	44.0
Froot Loops	47.4
Frosted Flakes	44.0
Frosted Mini Wheats	33.6
Fruity Pebbles	55.1
Granola	16.6
Granola (with almonds)	21.4
Granola (with dates)	14.5
Granola (with raisins)	14.5
Grape Nut Flakes	7.0

NAME	PERCENT SUCROSE
Grape Nuts	0.00
Heartland	23.1
Heartland (with raisins)	13.5
Honeycomb	48.8
King Vitamin	58.5
Kaboom	43.8
Life	14.5
Lucky Charms	50.4
Orange Quangaroos	44.7
Peanut Butter	5.2
Pink Panther	49.2
Post Toasties	4.1
Product 19	4.1
Puffed Rice	2.4
Puffed Wheat	3.5
Quisp	44.9
Raisin Bran (Kellogg)	10.6
Raisin Bran (Skinner)	9.6
Rice Chex	8.5
Rice Crispies (Kellogg)	10.0
Shredded Wheat (Large)	1.0
Shredded Wheat (Spoon)	1.3
Sir Grapefellow	40.7
Special K	4.4
Sugar Frosted Corn Flakes	15.6
Sugar Frosted Flakes	29.0
Sugar Pops	37.8
Sugar Smacks	61.3
Sugar Sparkled Corn Flakes	32.2
Super Sugar Chex	24.5
Super Orange Crisp	40.7
Super Sugar Crisp	40.7
Team	15.9
Total	8.1
Trix	46.6
Uncle Sam Cereal	2.4
Vanilla Crunch	45.8
Wheat Chex	2.6
Wheaties	4.7

* From a study by Dr. Ira Shannon, Veterans' Administration Hospital, Houston, Texas, Director, Oral Disease Research Laboratory

A LOOK AT FOUR FOOD CHAINS

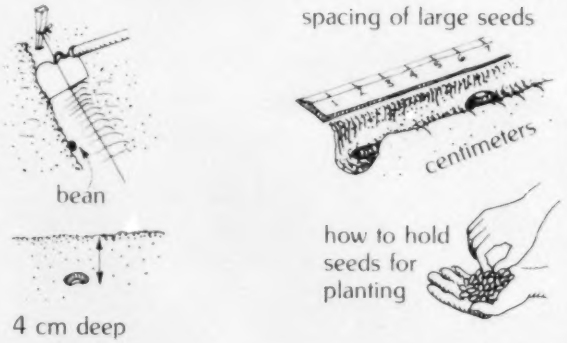
eat it	eat it	eat it	eat it	
	cook it	cook it	thaw it, cook it, throw away the package	
		take it home	take it home and put it in the freezer	
		you drive to market and buy it	you drive to market and buy it	
		they refrigerate it at the market	market keeps it frozen	
		it's transported to market	refrigerated truck takes it to market	
			it's sliced by a machine, packaged, and frozen	
			it's transported to a processing plant	
you grow a vegetable in your garden	you grow a vegetable in your garden	someone else grows a vegetable	someone else grows a vegetable	

TIPS FOR A SUCCESSFUL GARDEN

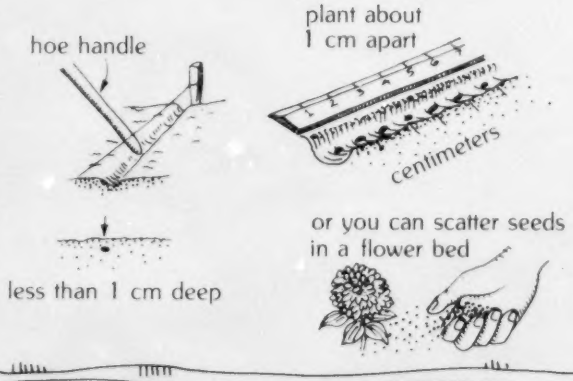
1 DIGGING AND FERTILIZING THE GROUND OF THE PLANTING PLACES

the lump test for soil condition
too wet
ready to work
dig each furrow full width of the garden
scatter fertilizer evenly and lightly
hoe forward

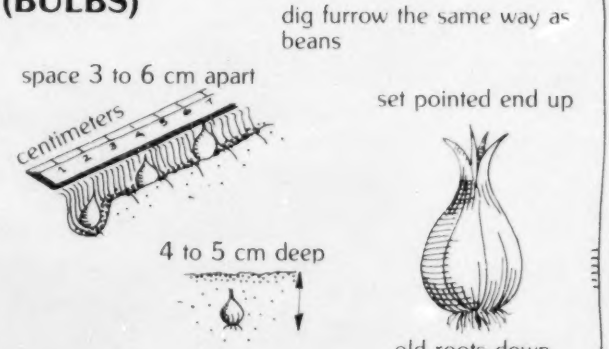
2 PLANTING GREEN BEAN SEEDS



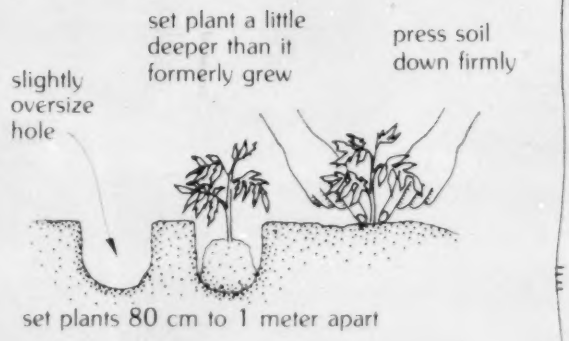
3 PLANTING ZINNIA SEEDS



4 PLANTING ONION SETS (BULBS)



5 PLANTING THE TOMATO PLANT


set plant a little deeper than it formerly grew
press soil down firmly
slightly oversize hole
set plants 80 cm to 1 meter apart

6 GROWING AND CARE OF PLANTS

* *From Cleveland Public Schools, Horticulture Department.*

GLOSSARY

Absorber or Absorber Plate:
A sheet of material, usually copper, aluminum, or steel, which absorbs solar heat and conducts it to the transfer medium. In some systems, this function is performed by the side of the building or by interior masonry elements like floors and walls.

Btu:
British thermal unit, used to measure heat: the amount of heat needed to raise the tempe ature of one pound of water one degree Fahrenheit.

Calorie:
A metric unit of heat energy: the amount of heat needed to raise the temperature of one gram of water one degree Centigrade.

Caloric Energy:
A term that expresses the energy producing value of food when it is burned in the body.

Coating:
Flat-black paint or some other highly absorptive substance applied to the absorber plate to help soak up, rather than reflect, sunlight.

Collector:
A device to trap the sun's radiation and convert it to usable heat. A well-designed building with south-facing windows may be considered a collector in the broad sense of the term. In its most common usage, collector refers to a panel made up of an absorber plate and glazing, surrounded by an insulated frame.

Composting:
An organic bed of material, containing manure, plant refuse, lawn cuttings, kitchen scraps, and other appropriate waste, that decomposes over a period of time and then forms together into a rich humus soil that can be used as a fertilizer. When oranic matter is broken down in an airtight container it is called **anaerobic composting**. When the organic matter is exposed to air it is called **aerobic composting.**

Conduction:
The transfer of heat energy from molecule to molecule within a substance.

Conservation:
Planned management of a natural resource to prevent exploitation, destruction or neglect; the use of natural resources in a way that assures their continuing availability to future generations.

Convection:
The transfer of heat energy by moving masses of matter, such as liquid or gas circulation. Convection is demonstrated in the natural upward movement of warm air and its replacement with cool air.

Food Chain:
A series of plants and animals linked by their food relationships. A green plant, a leaf-eating insect, and an insect-eating bird would form a simple food chain.

Heat Capacity:
A property of a material measured as the quantity of heat required to raise 1 cubic foot of material 1 degree fahrenheit.

Insolation:
The amount of solar radiation striking a given exposed surface.

Insulation:
A material with high resistance that retards the passage of electricity, heat and sound. Examples of some materials used as insulation are fiberglass, cellulose and mineral wool.

Kilowatt (kW):
A unit of power equal to 1000 watts, or 1000 joules per second, usually used in terms of electricity.

Life-cycle Costing:
Estimating long-term costs, such as energy consumption, maintenance and repair, and comparing them in several different systems. Many appropriate technologies require a substantial initial investment. However, their cost must be seen as an investment in energy over the period of time they will be used. After installation, other than maintenance and repair, most appropriate technology hardware (solar collectors, wind turbines, etc.) requires little cash outlay because the energy source is free and constant. Life-cycle costing takes into consideration the rising costs of conventional systems that rely heavily on non-renewable resources.

Megawatt (mW)
A unit of power equal to 1 million watts.

Non-renewable Resources:
Coal, natural gas and oil are non-renewable resources. Also called fossil fuels, they were formed over millions of years from organic materials (plants and animals) buried under tons of rock and debris and heated by the sun. They are considered a finite or limited resource because of the great length of time required for their formation and because their known reserves are limited and declining at a rapid pace.

Ocean Thermal Power Conversion Plants:
Temperature differences between the ocean's warm surface water and the cold deep currents are used to generate power. The ocean's top layer, heated by the sun, is relatively warm (about 80 degrees Fahrenheit); the lower layers (1500-5000 feet down) are much colder (30-40 degrees Fahrenheit). A sea power plant would draw warm water from the surface to heat a working fluid such as propane, ammonia or freon until it evaporates, creating steam. Pressure produced by the confined steam could rotate a turbine to power a generator. Cold water drawn up from the depths cools the working fluid until it condenses back into a liquid and the cycle is repeated.

Organic:
Having either animal or vegetable life; derived from living organisms.

Photovoltaic (Solar) Cell:
A cell mounted for exposure to light and connected through a sensitive current meter to terminals, converting solar energy directly into electricity. Sunlight striking certain materials (silicon is most commonly used) causes the release of electrons. The migration of the released electrons produces an electrical current. The conversion process is called the photovoltaic effect.

Proteins:
Extremely complex substances made up of many amino acids. A protein is formed when amino acids join together in a long chain. Proteins that contain all essential amino acids or proportions capable of promoting growth are described as complete proteins.

Radiation:
The emission and diffusion of rays of heat, light and electricity. The flow of energy, including solar energy, via electromagnetic waves.

Renewable Resource:
A resource derived from an endless or cyclical source, such as the sun, wind, falling water (hydroelectric), or biomass.

Retrofitting:
The modification of an existing building through the application of a new design

or additional fitting, such as a solar heating or cooling system, or a greenhouse.

Solar Thermal Conversion Systems:
An example of such a system is a power tower that concentrates direct radiation from the sun to heat liquids, creating steam. The generated steam can run standard electric turbine generating equipment.

Spaceship Earth:
A term coined to reflect our change in consciousness since astronauts looked at the earth from space and saw it as a floating planet of definite size. The astronauts saw the earth as a limited environment, just as the capsule they were orbiting in was limited and controlled. The concept has increased awareness of the earth's shrinking resources and of the need for cooperation on a world basis in order to live wisely on our "spaceship."

Specific Heat:
The quantity of heat, measured in Btus, needed to raise the temperature of one pound of material one degree Fahrenheit. The higher the material's specific heat value, the larger the amount of heat it can absorb and release.

Thermal Mass:
The characteristic of a material that allows it to store heat. Water has a greater thermal mass than stone or concrete, which in turn, retains more heat than wood.

Trombe Wall:
A masonry wall located directly inside south-facing glazing. The wall functions simultaneously as a structural element of the building and as a solar collector and heat storage unit. It was named after a Frenchman, Felix Trombe, who developed it in collaboration with architect Jacques Michel.

Weatherization:
The process of decreasing the energy needs of a building through reducing winter heat loss and summer heat gain. Examples of weatherization techniques are: use of storm windows, weather stripping around doors and windows, caulking cracks and insulating the walls and roof.